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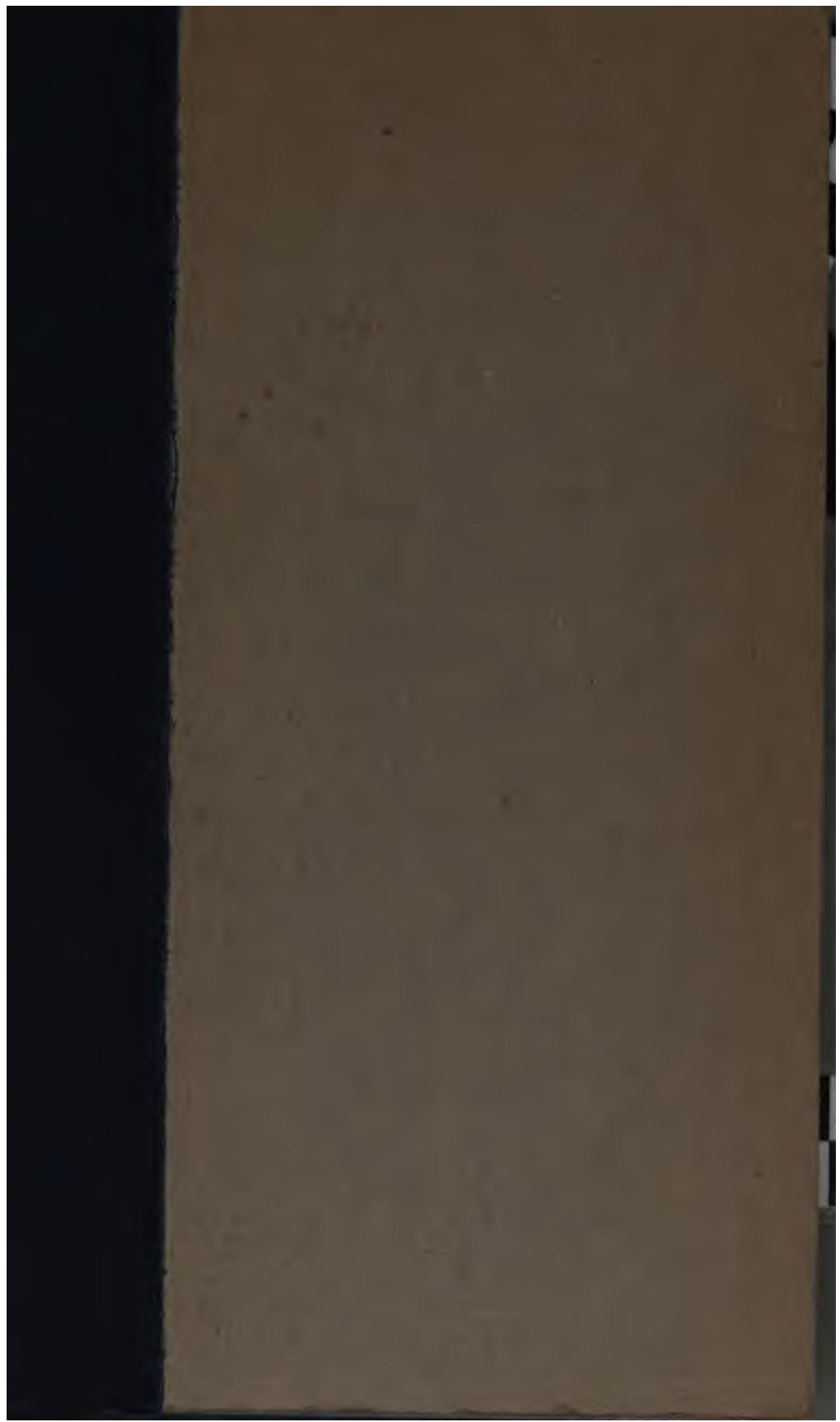
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# OUR RAILWAY SYSTEM VIEWED IN REFERENCE TO INVASION.

BEING A TRANSLATION OF A MEMOIR ENTITLED  
THE TRAINING OF RAILWAYS FOR WAR, IN TIME  
OF PEACE,

BY BARON M. M. VON WEBER,  
K. K. HOFFRATH,  
ENGINEER AND STATE DIRECTOR OF THE RAILWAYS OF THE AUSTRIAN EMPIRE.

WITH AN INTRODUCTION AND NOTES  
BY ROBERT MALLET, M.I.C.E., F.R.S.  
HON. M. R. ARTIL. AND U. S. INSTS.

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TO

FIELD-MARSHAL SIR JOHN F. BURGOYNE, BART.,

R.E., G.C.B., F.R.S., Hon. M.I.C.E., &c., &c.

DEAR SIR JOHN,

It is not alone with the view of giving weight to the following statements that I grace these pages with your name. I wished for an opportunity to record my own pleasant remembrances of intercourse extending over many years, during which I had the advantage of designing or executing many works, public and private, under your discerning eye and with your approval.

No man living combines your long and varied experiences of war, with that accurate knowledge of the works of the Civil Engineer afforded you by your laborious and distinguished career in various Civil appointments.

On these grounds, with others, it was that the late Duke of Wellington addressed that memorable letter to you intended to arouse our country to the peril of invasion. The danger is at least as great now as then, and as little provided against. As regards the deep importance of the subject treated of in the following pages, your permission here to address you cannot, therefore, be devoid of significance.

I have the honour to be, Sir John,

With the highest esteem,

Yours,

ROBERT MALLET.

LONDON, 15 Sept., 1871.



**OUR RAILWAY SYSTEM  
VIEWED IN REFERENCE TO INVASION.**

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**INTRODUCTION.**



## INTRODUCTION.

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THE author of the pamphlet, printed for private circulation only, and not purchasable ("Die Schulung der Eisenbahnen für den Krieg im Frieden"), of which, with a few slight alterations, the following pages contain an English translation, is Baron von Weber, a name celebrated and respected throughout Germany and Austria—his fame as a scientific railway engineer, indeed, reaching much further; his careful experimental treatise upon the principles of strength and endurance in the permanent way of railways being known to most well-informed engineers throughout the world.

The official labours of Weber were formerly those of Financial Controller (Finanzrath) and State or Ministerial Director of Railways in the Kingdom of Saxony, his functions as a railway engineer bringing him into intimate relations with the railway systems of nearly all the other States of Southern Germany; so that prior to the campaign of 1866, on him devolved the complicated and difficult arrangements for the movements by railway of nearly the whole of the armies of the South German kingdoms. Subsequently to that period Weber, upon whose abilities and experience Baron Beust, the Minister of the Austrian Monarchy, had long looked with confidence, was invited by the latter to accept the important position of Director-General of the system of Austrian railways, which he now occupies.

In Europe, France, Italy, and Germany, including Austria, have been the grandest fields upon which the powers and relations of railways to warfare have been displayed. It is to the skilled experience of such men as our author, therefore, that we should look for such facts and deductions as can be of

practical value to us in England, if at any time called upon to put our own railway system—hitherto exclusively consecrated to the uses of traffic and commerce in peace—to use as an implement of defensive warfare.

The main drift of Weber's pamphlet is to urge that every simplification, every uniformatisation, of the *materiel*, of the *personnel*, and of the *system of working* of railways which can be made, will be beneficial to their effective uses in time of peace, and in time of war must prove, *à fortiori*, of, we may truly say, incalculable value to the State, and therefore to every individual composing it in aggregate. Incidentally he points out what are the salient or indispensable conditions as to certain structural works, as well as of rolling stock, which must be fulfilled, if railways are to be available in war to the immense extent of which they are capable, when thoroughly well planned for use both in peace and war, in their works and in their system of management. These comprise in part, at least, what Weber signifies by the word "*schulung*," which, though very forcible and appropriate, scarcely admits of translation by our direct English equivalent—schooling.

Many of the remarks by which he forcibly points out the existing difficulties, due to the needless variety and complication of German railways, and more especially those which arise from the confusion of tongues and dialects in Southern Germany and the Austrian dominions, either do not apply, or apply with less pertinence, to our British lines and those of Ireland. Still, to the thoughtful railway engineer or scientific military man, even the least applicable of these remarks are suggestively of value: they point to *principles*, the neglect of which detracts from the power of every railway, in so far as in any way they are neglected; and they serve to convey to us a more distinct picture of the actual condition (Weber's work appeared in 1870) of German railways, and to contrast these with those of France and of England as implements of war.

The important relations of railways to warfare may be generalised under a few great heads:—

*Economy* in time and in the expenditure of muscular power in the concentration and movement of troops of all arms.

- 1 The like in the accumulation and transport of all *matériel* and of food.
- 2 Economy in time and in life in disencumbering armies of their sick, wounded, prisoners, and other *impedimenta* after battle.
- 3 Vast increase in the power of rapidly mobilising and concentrating men and *matériel*, of throwing great masses upon distant points, of reaching the frontier for defence when threatened, of suddenly attacking in force at unexpected points, of reinforcing points exposed to overpowering attack at the critical moment, of maintaining a line or base if suitably intersected by rail, of paralysing the movements of the enemy provided with, and therefore also relying upon, railways, by their interruption or destruction.

We may add, the *power* of dispensing with much of the paraphernalia of older systems—such as field ovens, &c.—by regularly and wholesomely feeding armies from cities or other points in a distant base; the power of easily transporting very heavy masses, whether single or aggregate, such as heavy siege guns, mortars, ammunition, and other *matériel*, such as, with transport only by horses and common roads, would be impracticable. In fact, rail and locomotive only come second to the steamship in the power of ponderous transport, and excel it in rapidity and certainty. Punctuality, as well as speed, in the movements of the several parts of a great combined operation are secured beyond anything that the old unaided marching system admitted, and hence the power is given to the commander to devise and carry through strategic combinations of a magnitude or complexity which he dare not attempt on the older system. Mobility, transportability, celerity, punctuality, and certainty are thus of the essence of railways in war. They enlarge the area of available national power. In fact, if used to the best advantage, and in combination with an efficient military system, they enable the whole power of a State, however great its territory, to be thrown with lightning rapidity upon a given point; they tend also to limit the area of actual conflict, and to reduce its duration, the experience of the last fifteen years proving that campaigns which under the greatest military geniuses of older times would have extended to months, or possibly years, are inevitably settled in a few weeks, or even in a few days.

If these enormous increments of military power, due to the same system of steam locomotion which is surely and steadily new-moulding every institution, caste, creed, and custom in the world, have made warfare now more crushingly terrible and decisive, our imagination must not mislead us as to the fact that to the peaceful inhabitants, outside the limits, at least, of the now narrowed and compressed theatre of war, the railway in war time has brought real relief and advantage.

The darker side of the picture is undoubtedly the immensely increased power of sudden aggression, and the strong tendency that the possession of such a power is pretty certain to produce—in all the great military monarchies, to attack and overpower their weaker neighbours—the tendency which Prussia has abundantly evinced since 1864, to “make might right.”

And this is promoted by the fact that the military value to any country of its railways is a function of the length of its trunk lines, and of the extent of its territory. To the rapid concentration and transport to the coast or frontier of the mobilised army, the railways of Russia, Austria, and, most of all, of Germany, are of far higher value to them than those of Belgium, Holland, or Denmark are to these countries. In the collecting and massing of troops we may truly say, as the line lengthens *vires acquirit eundo* : the greater its length, the greater the area of its force-collecting ground, and the greater the mass accumulable in its outlying extremity. The time of concentration is as the length of the line ; but the mass concentrated as the area of country that it commands, which, with equal distribution of railway accommodation per square mile of country, may be taken as increasing with something like half the square of the length of the trunk line. With the small area of feeble kingdoms, though these conditions remain still true, they are developable to a much smaller extent. On the other hand, whether for attack or defence, under the old road transport and marching system, distance in the point for attack, and extent of territory, whether for attack or defence, were in certain aspects elements of weakness which in a well-railroaded country exist no longer.

Thus Thiers tells us how, at the very outset of the Russian

campaign of Napoleon I., “the French troops arrived at the Niemen—on the Russian frontier only—were already fatigued by the immense marches they had performed. Wanting bread, salt, and spirits, or wine, they tired and were disgusted with the only diet that their system was able to produce for them day after day—flesh cooked and eaten without salt or condiments, and mixed only with flour and water; and the horses also lost condition for want of dry and sound food, although it was still in the midst of summer.” We need not pursue his picture of the already encumbered state of the army, from disabled and stragglers, and from its enormous train of carriages and baggage.—(Thiers’ *Hist. du Consul. et de l’Empire.*)

Here was a case of *attack* after the necessity of a march of some hundreds of miles. Russia herself affords us the *pendant* picture in the case of *defence*. Her chief feebleness in the Crimean war, and the final cause of her discomfiture at Sebastopol, was the impossibility of keeping up her forces and munitions over hundreds of miles of parched-up and desolate steppe, miscalled roads; huge columns that had quitted the far north and east of the interior, dwindled to a few broken-down battalions before they came in sight of Sebastopol.

Yet it is wonderful what was now and then achieved in overcoming distance and its difficulties on the old marching system, under the hand of one or two of its master spirits.

On the 9th September, 1805, after having broken up his camp and set forth from Boulogne, Napoleon had invaded Bavaria. On the 25th six marshals of France and as many army corps crossed the Rhine, and penetrated Central and Southern Germany; on the 15th September Napoleon struck the first decisive blow at Donauwerth, on the Danube, 375 geographical miles in a right line from Boulogne. On the 20th Mack capitulated at Ulm with 40,000 men, and by the night of the 2nd December Austerlitz had been fought and won, Vienna was entered, nearly 600 miles from Boulogne, and all was over for the time with Austria—and, in fact, with Germany. The mean distances marched in concentration by the various French corps was probably not less than 300 miles.

Such results achieved within six weeks from the outset were no doubt due to the inimitable skill with which Napoleon

combined the movements of his different corps, separated by wide intervals, and the exactness, like intuition, with which he calculated the times of their movements. The facts are marvellous even now; but the great lesson the strategist may derive from them is that such successes due to such combinations, under the older system, were only possible to a genius such as Napoleon, whereas, under that of the railway as an implement of warfare, they become the work of commanders of even ordinary abilities, and assume a character in many ways as mechanical as the mechanism itself that produces them. A few facts may be given as contrasting the older system with that of the railway in war, the rather as these afford some data for estimating what we, in Great Britain or in Ireland (with an efficient military system once established as a reality, but which remains yet to be formed), ought to be able to effect with our own noble system of railways, in the event of invasion.

We shall confine this to the transport of large masses from distant localities to points of concentration; for to deal with the strategic uses and working of railways in the actual theatre and operations of war, when employed as communications between the flanks, or with the base, demands more space than here could be afforded, and would be useless unless coupled with much purely strategic discussion. These latter capabilities and uses of railways the military student finds ample materials for studying in the French, Italian, and Austrian campaign of 1859, ending with the victory of Solferino, and still more in the American civil war. Many valuable examples have occurred in the late calamitous war in France, but the precise strategic circumstances of most of these are as yet too imperfectly known to form safe bases for inquiry.

A thorough knowledge of the conditions of concentration of great bodies upon a given point, or of *grands transports*, as called by the French, is also far more important to us nationally than those of railway strategics (*transports spéciaux*) in immediate presence of the enemy; for should we be threatened with invasion upon the great scale in which alone it will ever be attempted, it will be of infinitely greater importance to us to be in position to bring the utmost out of the power of our railway system, in pouring down troops and munitions

upon the points of the coast threatened, and so to be victorious in opposing any landing of hostile forces, than will any strategic help our railways can afford us afterwards in beating a great army once established upon our territory. The surface of our island, the distances between the most probably assailed coasts and the capital, are so small, the means of subsistence and shelter so ample, and so impossible to be rapidly removed from the enemy's reach, that once on *terra firma* in force and in good order, and marching legs alone cannot perhaps do as much as, but must very nearly approach to equality with, the possession of rails, *some* of which must then fall into the enemy's hands, and even if in an unworkable state, the possession must in so far paralyse the strategic uses to us of what may remain.

Probably the very earliest actual trial of a grand transport was made by Prussia in 1846, when the Sixth Army Corps was carried upon two lines into Cracovia; the Upper Silesian line carrying nearly 10,000 men, above 300 horses, 16 guns, 15 carriages (waggon train) of ammunition, and 30 of other *matériel*; and the Freybourg-Scheveiditz and Breslau line nearly 2,500 men, with their requisite baggage, &c.

This modest tentative was, however, largely exceeded in 1849, when a Russian corps of 30,000 men, with all its equipments, was transported from its cantonments in Poland by rail as far as Göding to effect its junction with the Austrian army.

In 1851 again, a Russian division of 15,000 men, with 2,000 horses and 48 guns, was carried from Cracovia to Hradish, a distance of 300 kilometres (187 miles), in two days. So that if we assume the usual marching rate of a large column at about twelve miles per day, with one day's halt per week, it would have taken fifteen days to make the distance by the old method; that is to say, the movement was effected at a speed *sevenfold* faster than on foot.

It was calculated by the Prussian Staff, in the summer of 1859, that the Fifth Army Corps, two divisions of infantry, two of cavalry, with reserve artillery and train, which was to be sent by rail from Posen and Breslau to Frankfort-on-the-Main, should occupy on the transit of 675 kilos. (422 miles) fourteen days. If the distance were marched, the time would have been two and a half times longer, and the troops

would have arrived with large numerical deficiency, jaded, foot-sore, and reduced in weight, strength, and discipline. That movement did not actually take place, but in 1866 many Prussian corps were transported to vast distances in from nine to twelve days, and generally realised something like the preceding difference in speed. In fact, in 1864 they effected better than this, for the Thirteenth Prussian Division of 15,000 men, 4,500 horses, and nearly 400 road carriages, was carried from Minden to Harbourg in six days, or three times as fast as by the march, and this was done without stopping the ordinary traffic, which in 1866, as well as last year, was in numerous instances completely suspended. These all, however, are comparatively slow rates to what are possible, and have been accomplished on non-German lines, so as fully to justify the strictures of Baron Weber in the following pages. For example, in the Franco-Italian war nearly 9,000 men and above 650 horses, with proportionate *matériel* and baggage, left Paris by the Paris and Lyons Railway *every day*, without for a moment interrupting the usual traffic; and between the 20th April and 15th July 115,000 men and 25,000 horses, with all their munitions and guns, carriages, &c., passed over the line, and all the cavalry of the guard (six full regiments) were carried from Paris all the way to Marseilles. The rate of transit was found to be *six* times faster than by marching, or *double as fast as the best rate achieved* on the German lines—again justifying Weber's preference for the French and Belgian and our own systems of lines and rolling stock.

In the same war (1859) the Third Austrian Corps d'Armée of 20,000 men, 5,500 horses, with guns, munitions, and nearly 300 waggons, was carried from Vienna to Lombardy in fourteen days. It required seventy-six trains and the complete stoppage of all other traffic; the speed realised being about four and a half times faster than by the march, or about a mean between French and German average speed.

It is, however, in countries where the distances are still greater that the railway system tells most powerfully. Thus, in 1863, Hooker's corps of 23,000 men, with all its artillery, *matériel*, and horses, was carried from the banks of the Rapidan, in Virginia, to Stevenson, in Alabama, or about 1,250 miles,

in *seven days*, a distance that would have required *three months* to compass by marching. Scofield's corps of 15,000 men, with proportionate *matériel*, also was carried, by river steam navigation and railway alternately, over nearly 1,600 miles in eleven days.

Such are the immense advantages of long trajects ; the other limit is found when the traject is *very short*. Thus an army corps can actually march from fifteen to twenty miles in as little time as it will take to embark and disembark it in railway trains, and to carry it at railway speed the same distance—a fact which so far justifies what has been said as to the slight strategic uses that our own railways could afford us in face of an enemy established in force upon our narrow soil between the southern coast and the capital.

In four days in September of last year, nearly 40,000 Belgian troops were carried north and south over the lines out of Bruxelles, in addition to more than 1,500 ordinary passengers—goods traffic, it is understood, being suspended, except that for the carriages and *matériel* of the army.

What can be done upon our own British lines has in reality never yet been tried, and, like everything else that regards our defence, will probably be postponed until it be too late.

Our transports of volunteers and of spectators on a few review days are no criterion at all, for volunteers are only men in uniform with rifles in their hands, and with a few rounds of blank ammunition. They have never yet been placed in the conditions of a *corps d'armée* in actual warfare ; they have scarcely any artillery, scarcely any cavalry, no stock of food, no ponderous supply of ammunition, no waggon train, neither pontoons nor entrenching tools, no field hospitals, no tents or camp equipage—in a word, not one of the many formidable but necessary *impedimenta* belonging to a real force taking the field in real warfare, and which are the very things that prolong embarkation, produce confusion, and delay departure by rail. In truth, volunteers, as regards the point before us, can only be regarded as so many excursionists for a day, with arms in their hands instead of fishing-rods or umbrellas.

The railway companies, on the other hand, have been informed for days beforehand of what will be required of them, and have ample time during the preceding day and night to

make up all their trains, so that there is nothing to do, on the Easter Monday, but bring up train after train to the platforms, and let the men walk into the carriages.

It is well known that the owners of our coasting steamships to and from the great cattle ports look upon it as a special advantage that their live freights walk on board and walk ashore, whereas all dead loading must be rolled or hoisted and stowed on board, and in the same way disembarked.

Now, without anything derogatory in the comparison, this is just the difference between embarking and disembarking volunteers as they actually are by rail, and doing the same if they were a real army corps, with every munition and appurtenance for keeping the field in actual war.

Hence the facts given as to the transport of the volunteers by the Brighton Railway, from London chiefly, on Easter Monday, 1863, by Captain Tyler, R.E., in his interesting lecture "On Railways Strategically considered," prove nothing really to the point.

It appears that on that occasion nearly 7,000 volunteers were carried in nine trains from London Bridge, and about 5,000 others from Victoria Station in seven trains, over fifty-three miles to Brighton, in an average time of two hours thirty-five minutes—that is, from the time of starting; no information is given as to how long each corps was waiting, or how long in being embarked from time of arrival at the station, and this must be added to give any just notion of the time of transit.

There were, it appears, 132,202 passengers of all sorts carried down or back on that day; if we deduct from these the 12,000 volunteers, it becomes obvious that the latter (who can, as said, only be viewed as excursionists in uniform) are but a drop in the bucket compared with the remainder (120,000) of the ordinary passengers, and yet the Brighton Company, to meet this unusual traffic, had to borrow seventy-two carriages from neighbouring lines, in addition to the use of seventy-nine carriages which came to them loaded with about 2,000 volunteers from other lines. To assume, therefore, from these data, that even a little corps of 12,000 men could reach the south coast from London, in a condition there to oppose an effective and prolonged resistance to an invader, in from two to three hours —especially if the orders of route were suddenly determined

on, and required instantly to be complied with by the railway companies—would be a great mistake. Still more would it prove a fatal error to suppose that, were the real army corps to be carried—not 12,000, but four or five times that number—the carriage of the whole in the same time (two to three hours) would be only a question of enough of carriage accommodation and of haulage power. The space and appliances for embarking such large masses are even of more importance than the supply of carriages, as we shall hereafter point out.

It will be advantangeous here to refer to some of the chief units of weight and space, and of the other conditions both of stations and of rolling stock, &c., which actual experience of warfare has enabled the continental powers to deduce, and to a large extent to reduce to a (*réglementaire*) system. These rules are nearly the same in France, Italy, and Belgium, but differ in several respects from those of Germany and Austria. Some of these differences are based on principles wherein the military authorities have come to different conclusions; as, for example, in France the rule is to despatch each portion of a division or corps in the order in which it arrives at the station, and without reference to the order in which it will take position in the field when disembarked; whilst in Prussia the rule is that the order of despatch shall be that of relative position in the field. And could arrival at the embarking station be effected in perfect succession, and there were station-room enough to prevent confusion by great aggregations of waiting troops, &c., the Prussian system may possibly be the more perfect practically, as it is theoretically. In view of actual facts, however, the French rule seems far simpler and better.

But the chief differences arise from structural differences between the French and German lines and their rolling stock, such as are referred to by Baron Weber.

At the present time so rude a shock has been given to our ancient confidence in French military (and all other) organisation, through ill success, that there is a strong tendency to underrate French arrangements, and to overrate those of Germany, as regards their respective adaptations of their railway systems for warfare. However, in the campaign of

1870-71, the facts, so far as they are yet accurately known, show no deficiency on the part of the French railways. On the contrary, the concentration on the frontier at the first outbreak was made with great facility, regularity, and speed, so as to have drawn forth the commendation of the Emperor in an order of the day addressed to the chiefs of the railway companies. The quickly-following disasters were in no way attributable to the railways. The Prussians had within nominally the same time massed a much larger force on their frontier facing the French; but there seems good ground for believing that a great deal of their concentration was silently carried on before the actual declaration of war, and but little is known as to the relative degree of comfort in which the troops of the respective armies were carried; whilst the terrible sufferings endured by the masses of French prisoners carried in open trucks, in the depth of a winter of unusual severity, seem to point to considerable differences between the theoretic rules and the actualities of the Prussian and German systems generally.

The mean weight of the French soldier—infantry of the line, *chasseurs à pied*, cavalry, foot artillery, and sappers and miners, with their arms and equipments—as ready to go into a railway carriage, is taken at 191½ lbs. (British). The weights of the cavalry horses (heavy, of the line, and light) vary from 560 to 394 kilos., or a mean of 499½ lbs. British, without saddles or equipments; those of the artillery and waggon train vary from 550 to 530 kilos., or a mean of 1,188 lbs. British; the widths, without saddles or harness, of all varying from 0·60 met. to 0·90 met., and the height from 1·86 met. to 1·76 met., or, practically, 1 met. (3·28 feet) per horse in breadth, by 2 met. (6·56 feet) in height. Upon these bases are fixed the load that shall not be exceeded upon each axle or pair of wheels in a train for military transport, this being the unit of load resistance (the number of axles), whether with four or six-wheeled carriages.

As to the dimensions, capacities, and weights of the military carriages, including field and siege artillery, upon which depend the sizes of the railway trucks that can carry them, we must refer to the French "Aide Mémoires" and to the German military "Festenbuch."

Cavalry and artillery always embark their horses unsaddled, but with the bridles and halters on, which are hooked up to rings, and partly held by the men told off to travel with the horses.

The men receive a ration of bread and cooked meat proportionate to the length of the journey, and pressed fodder for the horses is provided in the ratio of from 4 to 6 lbs. weight for any transit lasting less than twelve hours, and from 16 to 20 lbs. per diem for those of more than twenty-four hours. These have to be added to the weight of the men, horses, and ammunition.

The troops of all classes invariably take their arms with them into the carriages, and stringent rules are enforced as to how they shall carry these, their helmets or képis, &c., during the journey. While in motion, arms must be held between the knees, never put under the seats, on them, or in corners. Even the lances of the uhlans and lancers are put lengthwise into the carriages with them—a difficult and bad arrangement, and, as M. Body shows in his able work ("Aide Mémoire pour l'emploi des Chemins de Fer, &c."), they would be much better stowed along with the saddles in the vans containing these. In these vans the saddles and packs, &c., rolled with their surcings, are packed transversely in ranges, and above each other, each alternate range in height being inverted, and stowed between those beneath. Precise and full instructions are printed as to the methods of stowing these and every other article of military equipment, so as to produce rapidity and ease of embarkment and stowage without waste of space (which means loss of train power, and therefore loss of time), and to prevent danger and damage by shocks and friction in transit. Ammunition (except that in pouches), powder, explosives, and combustibles are interdicted from being ever sent in the same train with troops, and excellently well-thought-out rules have been framed as to the classes of carriage, the modes of stowage, and so forth, for the transport of these dangerous materials.

Spare space, to the extent of one seat in ten for troops of the line and foot artillery, and of one seat in five for the grenadiers, gendarmes, imperial guard, sappers, &c., is provided in fixing the capacity for the trains.

In France the load per axle varies from twelve to twenty-

three men, or from three and a half to five horses, and on the average three-quarters of a military carriage goes to the same. These differences arise partly from differences in the rolling stock, partly from the gradients and haulage power of the several lines.

In Prussia, owing to the construction of most of their carriages, one axle only takes ten officers, or sixteen soldiers, or three horses; so that the German calculation as to train-power required for transport is as follows:—

For 1 battalion of infantry of 900 men, 40 horses, and 5 carriages	88 axles.
1 battalion of chasseurs	92 "
1 squadron of 188 horses and 2 carriages	66 "
1 battery foot artillery	80 "
1 ditto horse artillery	75 "
1 ammunition column	110 "
1 battalion of pioneers	94 "
1 engineer detachment	23 "
1 section of pontoon train	60 "
1 division of field telegraph	54 "
1 subsistence column	122 "

The weight of a battalion of infantry is very nearly the same as that of a squadron of cavalry, or 120 to 125 tons; that of a battery of field artillery, or an ammunition column, about 200 tons. So that in Prussia a division of 12,000 men—infantry, with its proportion of cavalry and artillery—requires for its transport:—

Uhlans, or advanced guard	1 train.
12 battalions of infantry	12 "
12 squadrons of cavalry	12 "
2 batteries of artillery	2 "
1 ambulance	1 "
2 convoys of food, &c.	2 "

Or, in all . . . . . 30 trains;

which gives, as required for the transport of a single army corps, from 100 to 114 trains. The German rule is to make up the military train to double the number of axles usual (on the same line) for ordinary traffic, and to haul by two or more powerful goods engines. This is, however, more than doubtfully good practice. Those very heavy trains largely increase the risk of accident, especially on lines of heavy gradients, and tend to render the consequences of accident more formidable, and the block produced more prolonged; whilst the disablement of one engine may disable or stop the whole train. Light

trains, quickly despatched, travelling fast, and hauled by single powerful engines, present in every way greater advantages—as probably every reflective traffic-manager will at once admit.

In France the rule is to give one train to an infantry battalion of from 750 to 950 men, weighing about 97 to 100 tons; or, to one squadron of cavalry, of 160 to 195 men, 140 to 178 horses, weighing about 100 tons; or one-half battery to two-thirds, according to class of artillery, of 104 men, 108 horses, 3 guns, and 15 field-carriages; to 154 men, 162 horses, 4½ guns, and 22½ field-carriages, weighing, altogether, 98 to 125 tons; or, for the field-trains, 246 men, 318 horses, and 60 vehicles, weighing something like the same. The French system, therefore, is to limit the useful load of each military train to about 100 tons.

We may see at once, from either the German or the French point of view, that the Brighton Review case, above referred to, of 12,000 men, with their arms, and nothing else, despatched in sixteen trains, is, as already stated, inapplicable to actual warfare.

As to the rate of train despatch per day of twenty-four hours, the Austrian official regulations seem to let that depend upon the accommodation that the terminal stations may afford. Experience has given 12 to 16 trains per day as the average. In France, in 1859, they despatched as many as 30 trains a day from the Paris and Lyons stations, 17 military and 13 ordinary passenger trains; and since that, 24 trains in all, or 1 per hour, has been fixed as the best maximum.

In Prussia the rule is that, limiting the ordinary passenger traffic to 1 fast train per day each way, 8 to 10 trains on single lines, and 10 to 12 trains on double lines of way, should not be exceeded. During the hours of darkness there are many difficulties to be overcome in embarking troops, even with the best appliances; and with bad weather, or in winter, probably considerable deductions would have to be made from these rates of despatch.

The speed is fixed for both German and French military trains, including the sanatory stoppages necessary for the men. In reality, the practically possible speed depends upon whether the line be single or double, and what are the water and fuel supply, sidings, &c., along the line.

As a mean, 25 kilometres per hour have been fixed for France; but 35 kilometres per hour have been done during the Crimean war.

For Prussia it is 23 to 25 kilometres per hour, according to gradients.

Allowing for the necessary halts on the way, and for the equally essential rest for the troops after a long railway journey, the Prussian calculation is, that from three to five days are necessary for transport of a corps over from 300 to 900 kilometres, so that, at the end of that term, they shall be fit for immediate action. The Prussian trunk lines have all been militarily divided into what are called "railway marches," each such march being capable of being run through in forty-eight hours.

As to the judicious rules that have been ordained for the mode of making up the parts of each military train in relation to its contents, for the detailed methods of loading each military specialty, for the safe conduct of these on the way, for the regulations of the trains *en route*, and much more, we must refer again to the German and French military textbooks, as these regulations for France only, extend to a small volume, though concise, clear, and well classified.

It were greatly to be desired that some equally well-thought-out handbook for the military services of our railways were produced, and placed in the hands of every traffic manager and higher railway servant in Great Britain and Ireland.

The only printed instructions, so far as we are aware, that exist, even for military men of an official character, are contained in the very meagre, and in some respects even inaccurate, chapter in the "Woolwich Handbook for Field Service," consisting of three pages. And one may be permitted to doubt that the vast majority of our railway managers, &c., have even the most elementary knowledge of the military conditions and requirements of the great instrument of locomotion they so admirably handle for civil purposes, when diverted to those of warfare.

We can take but a rapid glance at the general regulations in force for the railway embarkations and disembarkations of infantry, cavalry, artillery, &c. The actual regulations in detail occupy many pages of print.

The railway authorities at the station of embarkation, having been apprised as to what is intended sufficiently long before to enable them to make their arrangements, are assumed to have got ready upon sidings, inside and adjacent to the station, a sufficient number of trains and engines, made up of the proper classes of carriages, &c. The troops are marched to the station, and halted inside the courts of the station, and under cover, if there be room enough; if not, in the nearest open spaces or streets, and are formed in line. The officers, above a certain rank, enter the station, and make their *reconnaissance*—that is, examine, along with the chief railway authorities, the platform spaces, and learn the dispositions made as to trains.

Assuming these to be right, the officers return to the troops (whether infantry or cavalry), and give orders for their subdivision (*fractionnement*) into such small bodies, first as each train, then as the carriages of that train will admit. The infantry then enter the station in a long narrow column, preserving its subdivisions, and halt upon the proper platforms, where they should find themselves opposite the train ready for them. The adjutant stands at the station entrance, and hands *in writing* to each subaltern commanding a company where he is to go, and the number by which his train will be known. Troops and train being ready, the non-commis-  
sioned officers subdivide each carriage group into the number to fill each carriage body (reserving every tenth place), and the command is given by word in the case of infantry, by trumpet in that of all other arms, to embark. The men at once take off their *képis*, or head gear, and haversacks, and bring their pouches in front, and enter the carriages. The corporal in each body, or the sergeant of more than one, sees that the tenth vacant place is duly reserved, and in it the haversacks are stowed; so that the space between the seats is quite free for the men's limbs and for their arms, held between the knees.

The commanding officer now indicates to the station-master that his work is complete, and the engine, or more than one, is backed, and hooked on, and the doors are closed by the railway servants; and on the commanding officer being informed that all is ready, he directs the station-master to start the train. Where practicable the engines are reserved at some

little distance up to the last moment, on the wise ground that nothing is more distracting to those giving or receiving commands than the wurling roar of blowing off steam ; for the same reason the signal whistling on the part of the engine-drivers is limited as much as possible—a regulation that even in our every-day traffic at most of our large stations might, with great increase of comfort and advantage, be put in force. At present drivers whistle with little or no sufficient reason ; and when beneath a concave glass roof, as at Birmingham, the noise is frequently such as to render the voice inaudible, and communication with porters or others uncertain or impossible at times, and most distressing always.

While the subdivision of the infantry is proceeding, the officers' baggage and their horses are brought to their place and loaded.

The rule is that all making up of trains for military service shall be complete on the part of the railway at least half an hour before the indicated time for departure, and that the troops shall arrive, if infantry, an hour, if cavalry or artillery, two hours, at least before that time. Where troops are embarked at some point on a line where there are neither stations nor platforms, portable inclined planes (*rampes*) of plank, varying in surface from 2 feet 5 inches long by 1 foot 4 inches wide to 1 foot by 8 inches, are provided, to enable them to ascend the carriages with their arms and accoutrements without climbing or scrambling ; and where the disembarkation is to be made at such a locality these ramps are carried in trucks at the rear of the train.

Special regulations fix where in each train the horses, the baggage, the musical instruments, and the men and officers shall be allocated, giving a special place to the men who at the halt are to form the advanced guard or pickets of the force.

As the train approaches its destination the men are informed, and directed to be ready to quit the carriages. For this the system of lateral communication along the train in most continental railways offers great facility which does not exist on our lines. In fact, without some special arrangement such notification cannot be communicated on our lines, except by halting the train for a few minutes.

The halts along the transit for water and fuel, and for the necessary permission to the men to descend occasionally, are, as far as practicable, made to coincide, so as to save time; and knowledge as to these times is given to the adjutants on starting by the railway authorities.

As regards the disembarkation little need be said, further than that it is, in converse order, the same set of operations as in embarking. A squad is told off, however, to assist the railway servants in disembarking the baggage, horses, &c.; and if the disembarkation has of necessity to be effected where there is neither station nor platforms, the engine-driver, under the authority of an officer, chooses the nearest spot on the line, where it is most level, and neither on embankment nor in cutting.

As regards the embarkation of cavalry, nearly all stated for infantry likewise applies, and the mass of the men go into the train in the same way, reserving enough of men to travel in the vans with the horses.

As a rule, the horses are unsaddled, and enter the vans with only bridle and halter, and are loaded crossways to the van, head and tail, and only given about twelve inches of spare space to each horse; so that though able to move a little, they cannot lie down nor easily kick.

The saddles, as we have said, are loaded separately in covered vans, with all the trooper's heavy gear. He reserves his coat, arms, and haversack, and takes these with him. When it becomes inevitable to send the horses in open trucks or cattle vans, it is usual not to unsaddle them, if the weather be cold; but, if it be wet, this is attended with great evils and risk of health from wet saddles to the men.

Waterproof tarpaulins have been used in France; but the flapping about, as they must be left open for ventilation, none but old trained horses will stand, and waterproof horse-cloths would be a great improvement. Horse-boxes are only employed for the officers' chargers. There are numerous regulations and indications as to the best methods for embarking young or untrained horses, or those of remounted regiments, into which we shall not enter, nor into the many details as to spacing and loading the vans and carriages, so as to avoid loss of space, and so useless dead load.

The cavalry arrived at the station, if this be a first-class or large one, march into one or more of the enclosed yards — generally in connection with the goods departments — where, at the proper time, and after the same reconnaissance and communication between the officers in command and the railway officials, the command of unsaddling is given, squads being then set to work under subaltern officers to carry to the vans and stow the saddles.

Others attend to the loading of the baggage, its carriages, and of the officers' chargers, and generally of whatever *impedimenta* can be soonest got into carriages. These are often not hooked on to the rest of the train until after the men are embarked. The arrangements for getting the troop horses loaded depends in great degree upon whether the vans open at the end or at the sides, and upon this depends whether they must be loaded in goods sheds or docks, or can be so from platforms of such a character as the horses can have foot-hold upon.

The unsaddling, the stowage of equipments, the fractionising, grouping, and holding of the horses until their time comes for being embarked, together with the numerical parade, subdividing of the men, telling off of the working parties, and their operations, all involve a great amount of space, and where this is cramped and deficient, the result is confusion and delay.

French experience has shown that a squadron of cavalry can be embarked, ready to start, in from twenty to sixty minutes, according to the facilities presented by station, plant, and horse-vans, the quickest loaded being those that open at the side; but the actual time averages more than this. The disembarkation is effected in about half the time of the embarkation, where appliances are suitable.

As regards the embarkation of artillery, the regulations for infantry and cavalry, *pro tanto*, apply; but the loading of the guns, limbers, spare carriages, and ammunition involves additional operations and much additional labour. The loading of these *can* be performed without cranes, or even docks, and by the help of ramps and mere men's force; but cranes and ample platform space, suited to the foot-hold of horses and men, are indispensable if the embarkation of artillery is to be conducted with regularity and despatch.

In Prussia and France, where the inside dimensions of every van, truck, and carriage are known and registered, rules have been made as to what proportions of guns and carriages, &c., shall go to each size of truck, so as to economise to the best useless dead load, &c., and also as to the precise mode of loading and placing each gun and carriage in the truck in reference to the direction of motion *en route*, so as to minimise damage in the event of break-down or collision. Also as to the modes of securing them against movement, friction, or shocks in starting and stopping.

Rules also exist applicable to field artillery, and others as to siege guns and garrison munitions; others as to the modes in which ammunition must be carried, and the position to be occupied by the ammunition vans in the train; where the brake-carriages are to be placed in reference to those containing ammunition; how these vans, which *must* be always covered by fixed roofs, and not opening by the ends, shall be examined from time to time, *en route*, and any loose powder or powder dust that may have shaken out and got on the floor, and been vibrated into corners, shall be swept out, or at least wetted.

Special rules also are framed for the loading of provision, hospital, and pontoon trains; the last requiring trucks as long as those for the transport of timber, but with special arrangements for the security of the pontoons.

As with us, the waggons and trucks of ordinary traffic vary in size on Belgian, French, and German lines, the greater proportion being for 5 ton and 10 ton loads. There are 5 ton coal waggons of 4.42 metres, and 10 ton ones of 4.60 metres clear length—these only can carry three artillery trains, the gun, and two carriages; the 10 ton trucks, also of 5.41 metres, and 10 ton trucks of 6.15 metres, and 10 ton coal waggons of 5.65 metres in length—these can carry four, and the trucks even five in case of necessity, guns and carriages. There are also flat waggons of eight wheels carrying 20 tons, 10.08 metres in length, which can carry eight guns and carriages together.

The minimum thickness of floor for safe carriage of guns has been fixed at 0.05 metres (2 inches), and if found less the floors are strengthened by planking over partially.

These and other facts and regulations, resulting from their having been experimentally ascertained and known both to the military authorities and to those of the railways, enable the latter, as soon as they receive the requisition to transport a given quantity of troops and *matériel* of any arm, to decide upon the classes of carriages, their number, &c., &c., that shall afford the necessary accommodation sufficiently ample, but with the least possible loss of space or useless load.

It has been found that all wheeled carriages can be loaded with the greatest celerity, though not with the least labour, where such turntable and other arrangements exist that they can be rolled on to the trucks directly from the platform, that being nearly level with their floors. In this way, as the number of available hands is practically unlimited, it has been found that thirty artillery carriages, including field guns, can be loaded in about an hour; but these require from two to four hours if slung and loaded all by cranes. Still, as many of the carriages have, for better stowage, to be more or less dismounted, cranes are indispensable. This French and German experience of what can be done with cranes is based upon the use of those clumsy hand-wrought cranes which are chiefly found at all the stations. There can, however, be no doubt that with well-constructed steam or hydraulic cranes, on platforms properly adapted to the bringing up and ranging the guns and carriages at one side, and hoisting them in on the opposite one to the trucks, the latter ranging along and moved off as loaded, and their place taken by the empties, and by the help of properly thought-out and adapted slings, &c., all fitted to the several classes of carriage, the mechanical loading system for embarking artillery would be found not only superior in celerity, but would save the labour, clothes, and risk of limb of the men, whom it is not wise to harass with severe labour at the start on a journey by rail, and thus send them into the carriages in the best condition to get colds and other sickness.

A few words remain to be stated as to the organisation abroad of the official communications as to military transport between the military authorities and those of the railways. Over many parts of the Continent the railways are of two classes, State lines and private lines. Over the former the State and the commanders of its army are obviously entitled to direct autho-

rity. In France the concessions of all the lines reserve over them State authority as respects military amongst other purposes; and in Germany the whole social system is so completely moulded to the military element which interpenetrates it, that every line really views itself as obliged to obey whatever orders of a military character it may receive in peace or war.

After war has been declared, and the armies are mobilised and being concentrated and moved, the railway authority of every continental kingdom in reality passes from a state of more or less independence, and becomes primarily amenable only to military direction. This is indeed inevitable, and were we in danger of invasion it would have to come to the same result with us, as regards many lines at least. We do not like dragooning, and in an important sense railways, that is their authorities, cannot be dragooned. It is of the highest importance, in fact, both to the rapid and effective movement of the army, and to the least amount of disturbance of the ordinary traffic coincident with it, that the railway authorities should work not by command, or even under threats, but cordially and in united intent with those of the army; and *this is only possible where both these parties know thoroughly not only what must be done, but how it is to be done.*

The commanding officer who does not know the latter, and whose only thought is to obey his orders and push to the required point by rail, may storm and threaten the railway officer in vain if the latter can only, under the circumstances of his case, reply with a *non possumus*, and the military man be too unacquainted with the minutiae of railway management to understand the difficulty, if real, or to detect the desire to elude him on the part of the railway officer, should such exist, or to decide how far difficulties as stated to him may be partly true and partly exaggerated, or wholly artificial; and until he shall have been able to come to some such conclusion, after due conference with the railway authorities, threatening or extreme measures are premature.

What has insured then a very perfect *entente cordiale*, on the part of all the railway authorities over the Continent, with the military service, is the conviction on both sides that each has learnt enough of the details of the other's business to

promptly detect excuse-making, laches, unwillingness, or disloyalty, on the one side ; and not to demand except what can be, and therefore must be done, on the other.

This it was that carried through the Prussians in 1866, when having to deal with many lines of railway, with directorates far from favourable to them.

Thus we see one of the moral consequences of the training of military men, of all ranks, to the intimate nature of railway works and management, and of railway authorities to the requirements of military transport, while peace exists.

In France the notification for the railway transport of every military body originates from the office of the Minister of War, whence it passes to the general commander of the body to be moved, and from him to his staff-officers, who put themselves in communication with the officers of the railway, or section of it, which is requisitioned for the service. The requisition to the railway is on a printed form, which differs according to the arms of the body to be moved, whether it be infantry, cavalry, or what not. This form sets forth the date and time fixed for departure, the number of officers and non-commissioned officers, and men, horses, guns, carriages, baggage, &c., the weight of the last being stated. Personal conferences between the staff-officers and those of the railway arrange as to the capacity of the line to perform the service ; and the morning before, or on that of the departure, an officer goes to the station, and ascertains by inspection that all needful has been got ready, or will be so.

In Prussia and Austria the routine is rather different, and less direct. After preliminary communications, passed between the Ministries of War (taking the initiative), of Commerce, and of the Interior, the project for the concentration or transport passes to the office of the general staff, where it is reduced to a concrete plan, after discussion as to the best lines, or parts of lines, to be employed ; and this passes for consideration or revision to a central mixed commission, presided over by a military officer of high rank, and comprising officers from the Ministry of War, from the general staff, and from the councils of the two other Ministries, three of whom are competent to decide upon it. Two of its members, viz., the officer of the general staff and the representative of the Minister of

Commerce, then become the executive officers, who see that the rules and forms are issued and complied with, and communicate the state of the case to the commander of the body to be moved.

When the concentrations are to take place, following the mobilisation of the army—either of Prussia or of Austria—a permanent commission, consisting of an officer of the general staff and a superior officer of the railway *bureau*, of the Ministry of Commerce and of the Interior, called the “Commission of the Line,” is formed for each of the grand divisions of the network of military districts into which the whole country is divided ; and their business is to exercise a general control over all the railway movements, and to see that the military transports are made, and report that they have been so to head-quarters, and in accordance with instructions issued ; to take the initiative in requiring all such arrangements to be made by the several and respective railways as shall fulfil the orders given as to embarkation, disembarkation, and feeding *en route* the troops, and generally to organise to the best advantage the lines within its district for the public service —first of war, next of ordinary traffic. As the concentration proceeds, a district “Commission of the Line” is formed at the head-quarters of each *corps d’armée*, which sits at the chief railway-station nearest ; and is divided into two *bureaux*, one for control of *matériel*, food, &c., in transit ; the other for *personnel*, and which arranges everything that relates to the march of contingents coming to, or departing from, the main body by rail and road. Distinct rules are laid down as to the obedience to be rendered by commanders of bodies in transport to transport officers of whatever rank on the way ; and, again, as to the obedience that the railway officers must yield to the representatives of the army ; but these, and very many details of regulation, we must pass over. It need scarcely be stated that, in arranging for great transports, the order of departure of the bodies of the several arms, of provisions, ammunition, tents, ambulances, &c., &c., is purely a matter of strategy and tactics, and rests wholly with the military authorities.

Having thus briefly, and without any pretence to completeness, sketched the marvellous system which, within about

twenty years, has grown up, and become very perfect, though still being daily improved upon, for the adaptation of the railway system to warfare over the whole Continent of Europe ; which enabled nearly six hundred thousand Germans, and more than half as many French troops, to confront each other along a narrow strip of conterminous frontier, within a few weeks of the outbreak of war ; and which effected such great results in supplying the German armies after their irruption into the heart of France, and in their conduct of perhaps the largest investment and siege that have ever occurred ; let us turn to our own country, and present a few considerations as to the military or war uses of our British and Irish railways, with a view to discover how far we and they are at present in position to be as effective in war for the defence of our country, as they are potent for the regular conveying our peaceful traffic.

If ever, or rather, to avoid the self-deceptive if, whenever England shall once more be engaged in war upon foreign soil, or by sea only were that possible, our railway system will be called upon to perform important tasks in the conveyance of troops and *materiel* to our ports for embarkation, probably in carrying back sick and wounded, and possibly in conveying prisoners into dépôts in the interior ; and these may occasionally involve a more or less serious pressure along particular lines. But the smallness of our island, as already adverted to; the driblets of men that, as of old, we are most likely to send abroad ; and our conceiving, or rather deceiving ourselves as to the notion that we are only a maritime power, with other causes, will tend to make our railway military operations at such a juncture, if not of less importance, at least of less magnitude and difficulty.

What we really have to look to, and ought to consider in all exactitude and detail, is how our railway system shall be made the very most of as one part of a great co-operative machine for repelling foreign invasion of our own shores. Modern strategy says, and the most modern wars have proved the truth of the maxim, that the true defensive warfare is aggressive defence ; that whereby in 1866 and 1870, Prussia, when threatened with invasion by Austria and France respectively, in each case carried the war at once over its own frontier and into its opponent's country. This might, no doubt, cause a descent upon our own shores, as the first step to resist our

aiding or protecting a colony, or a European ally, or guaranteed neutral. Conversely, our own first line of defence being our fleet, in the contingency of our being the parties against whom war should be declared, or in that of our being compelled to declare it against an enemy hostile and evidently preparing for aggression, our business would be at once to attack him in his own ports if possible, and to this our iron railways could only play an auxiliary part.

Our enemy on the Continent, Germany or Russia for example, might be but little amenable to naval attack, however effectually our fleet might imprison in their naval ports their hostile squadrons. Blockades, since the powers of steam navigation have become developed, are notoriously less capable of long and rigid enforcement than in older times, and accidents or complications might so easily arise, especially were we engaged at once with two great hostile Powers, such as Russia and America, and accidental derangements of the best plans of naval strategies are, we may say, so certain to arise, that it would be madness to trust (as so many so-called statesmen of the "give peace in our time, O Lord!" school profess to do) for the prevention or the repulsion of invasion to our fleets alone. It is no less folly to delicately avoid the unpoliteness of venturing to name the nations who may make probably efforts at a future and perhaps not very distant day to humble if not crush us. We are envied, disliked, distrusted, and have begun perhaps to be despised, and by many different foreign Powers. To pretend then to ignore their probable combinations for carrying out their respective aggressive policies, and, if necessary to them, for our downfall, and to avoid all allusion to them, for fear of giving offence, is the wisdom of the ostrich when hiding its head in the sand. As Germany amuses (only perhaps) its military leisure in peace, by planning the most effective methods for the invasion of its neighbours, ourselves included, so is it our business now in peace, and while time is yet allowed us, to boldly discuss all probable combinations likely to come of the nations who may be our future active enemies, and to provide against them.

Our great concern then, in reference to such a conjuncture, is, as respects our railway system, to work out in every detail how we shall make that most effectual as the great means of concentrating, in the briefest possible time (within a few hours

at most), the largest possible force, provided with everything it should need, upon one or upon two, or on several points of our own coasts, which, though not our frontier as a naval nation, are our frontier in reality, unless we endorse the madness, as we have called it, of trusting to our fleet alone, which might be anywhere but where it was wanted in the hour of need. In fact, whatever may be idyllically said or sung about our "strip of silver sea," we have, if common sense be left to us, just as good reason for all that railway and other forethought, for the suddenly throwing a preponderant force upon any point of our coasts, as Germany and France have had for working out the like problems in respect to their own conterminous frontiers.

Were we always in future to continue in our present chaotic military attitude and condition, there would, it must be admitted, be something absurd in thinking out how one hundred thousand troops are quickest to be concentrated somewhere upon our coast, seeing that at this time it may be fairly doubted that even with a month's notice we could find and array even twenty thousand effective trained troops in all, and bring them anywhere into the field, for at present we leave out of view the volunteers, as to whom more anon.

But things cannot always, or perhaps very long, continue so, and we may rationally expect and must here assume that the nation will come to see, before it shall be compelled to open its eyes to the fact by some great military disaster and humiliation, when it will be most probably too late, that we must adopt the compulsory military service in defence of the State of every able-bodied man, and train all effectually, though with quick rotation, and therefore short terms of service, to be genuine soldiers, ready at the first trumpet-call to stand in solid array for defence of the State. The cuckoo-cry, that the nation won't bear that, is absurd, for the nation has never been asked, much less tried; and the greater our comforts and blessings of peace, the greater reason for such individual sacrifices on the part of all to preserve them to all. Playing soldiers now and then under the name of Volunteers, won't do this, however it may serve to blind our eyes as to the necessity for doing the other.

We may therefore assume, in reference to our subject, that (let us hope before the day of trial) England will be provided

with a real army of her own trained adult males ; that both our islands will be divided into sufficiently small military districts, each with its central point of head-quarters, and under its own commander, each complete with its artillery and stores, and complete train of waggon transport, and all so connected as to admit of rapid mobilisation, concentration, and mutual support.

We shall then have an army equal to any home emergency at least, and then the aid that our railways must be in the best position to afford for its concentration and transport in masses, comes to the front as important to be thought out, and in peace time regulated in every detail.

We do not as a nation at large realise or believe in the probabilities of our being invaded. Invasion is to the mass even of educated Englishmen a myth, supposed possible, like the millennium, at some indefinite future ; few indeed regard it as a terrible reality, that with all its dismal consequences may burst upon us any day, and with little more previous notice than gives the thunder-cloud that suddenly darkens and then flashes in the hour before tranquil summer heaven.

The last actual invasion was so long ago, seven hundred years, and the last two great attempts, see what became of them : the Armada, *affavit Deus et dissipantur*, and the Boulogne flotilla, what became of *it* ? Let us make ourselves easy ; it can't be done, and so it won't be tried. It was an ugly result of the first invasion, however, that one great battle lost upon the south coast changed in permanence the rulers of England. Had the Armada consisted of steamships of to-day, instead of rolling lumps of carving and gilding, the providential *afflatus* might have been less effectual ; and as to the Boulogne flotilla, our fathers did not shut their eyes to it, but manfully prepared, with all needful sacrifices, collective and individual, to meet it ; and had they not done so, we might have a different history now to look back upon. They had been in a state of warfare for years before, and they had ample notice and time given them to prepare resistance on our own land ; and they had a fleet, with such men as Nelson and Collingwood, flushed with never-failing victories in every region of the earth ; while we have a nearly untried fleet of untried monsters of divers doubtful and irreconcilable breeds, and few commanders or sailors that ever saw in their lives an enemy's fleet engaged with, much

less many such shattered, sunk, or towed away as prizes. Fleets, both as to ships and crews, must win their experience and prestige ; these a career of victory alone gives, and nearly half a century of maritime peace, at least as respects ourselves, has precluded this ; while the mighty constructional changes which steam, iron armour, rifled artillery, torpedoes, and so forth, have produced within the last twenty years, render the issues of the next great naval war nothing but an untried experiment. Iron-clad fleets have never yet been tried against each other on a large scale, nor with first-class and nearly equally-matched opponents : let us, therefore, not repose in blind confidence as to what is told us so often, that our fleet is the most powerful in the world, &c., &c. It may be so now, it may not be so hereafter, or at any moment, with a coalition of naval powers against us ; and preponderance of naval force, however great, might signally fail to prevent invasion. Let us not forget that Buonaparte succeeded in getting to Egypt and getting back again through the Mediterranean when held by the British fleet, and swarming with our cruisers ; nor, on the other hand, that the landing of William of Orange was a real invasion, and the fleet under Lord Dartmouth ready to offer a stout resistance. Yet William's fleet sailed past the Thames, where that admiral lay wind-bound, passed Portsmouth, and the landing was effected in Torbay before Lord Dartmouth was able to come up. All were sailing ships, and so as equally matched as if all were steamships.

Physically, then, invasion is a thing possible ; and strategically viewed as the science of warfare now stands, it is, we may perhaps say, the most probable form in which the first great blow would be chosen for delivery by any great military and naval power, or coalition of such. The day for petty descents upon an enemy's coast is gone by ; we shall never again have such invasions of Ireland as those under Hoche and Humber, or the demonstration at Fishguard. Of two things we may be certain, that no invasion of our land will now be attempted except in enormous force, and that we shall have but a few days' notice at the most of the enemy's real intentions.

It would be idle here to insist upon the blinds and specious explanations always given for the collection of armaments, and how unwillingly the nation to be attacked believes before-

hand that itself is to be the real victim. If all our preparations be not made before the time comes for diplomatic demand of explanations of what the armaments in such or such northern or far western ports at either side of the Atlantic may mean, and that diplomacy has cleared its vision as to what they really shall mean, they will never be made at all, for no time will remain for them.

The railway-military system abroad has made the concentration of two or three hundred thousand men and munitions upon the shipping ports a matter of hours, all the prior work of preparation being kept quietly out of our sight, or our eyes blinded as to its real objects. The transport of such living masses, in comfortable condition and ready to fight instantly, which was physically impossible in Nelson's day, is now by help of steam, even by that of mercantile steamships seized for the purpose, a matter of certainty and ease; and as to time, of hours.

Again, then, our great concern is, let the fleet do its best, but let us be prepared to throw upon our coasts at the threatened points a fighting force more quickly still than the enemy, and preponderant in number and power, so that should he succeed in landing, he may be at once engaged, and the first engagement prove decisive of his discomfiture.

It will not answer except in type, as in that absurd parody and converse of "The Battle of Dorking," "The New Armada," in the *Times* (1871), to suppose that the power to concentrate some five thousand men or so, chiefly artillery and volunteers, upon the point the enemy intends to land at, will suffice for all military ends. The landing of a great force at all, if opposed efficaciously, would confessedly be a matter of difficulty, and might be one of terrible slaughter. There is great room for cutting, however, in 100,000 or more men, and it is far from certain that our best efforts, and best directed, might succeed in preventing the invaders landing. Once landed and formed in force, what then would become of the 5,000, or even 20,000, men who had been blazing away at the boats and steam launches, and had shouted as they saw the hundreds of corpses thrown out of these, under their storm of shell and grape? Simply they must fall back before an immensely superior force, and by having to do so, permit the enemy to fully establish himself on English soil. Once thus and there,

don't let us deceive ourselves as to the enormous advantages of position he will have achieved, nor fancy that even though his ships might before long be destroyed or scattered behind him, he would early be brought to surrender. With a small body it might prove so, but not with an army of 100,000 men or more, without the needless encumbrance of food trains, but with, we may suppose, abundance of ammunition, and trusting for all else to the smallness and extreme richness of our country, and to its own rapid and irresistible advance upon the capital, &c. We *could not* starve out such a force, but if ever, not for weary months of requisitioning, disorder, misery, havoc, and social dislocation.

Everything points the one way. We may not be able to hinder their landing, though possibly at a terrible sacrifice ; but if not, we must be able to meet them in line of battle, at the very first favourable position after they shall have left the shore at their backs ; and to do either, but especially the latter, we must be able to hold our forces at their points of gathering for hours, or perhaps for days, like hounds in the leash ; and at an hour's notice, and within two or three in total time, to pour down upon the landing point or points, once ascertained, not 5,000, but a force numerically greater than that of the enemy as yet afloat, and which we may on strategic grounds estimate at not less than 100,000 men. This is the task as to which we ask, then, are our railways, their system, their servants, and the mutual understanding between them and the military authorities and officers generally, in fit condition to perform, with the minimum of confusion and the maximum of celerity ? If not, the sooner we commence the schooling, both of one and the other, the better, even though our own army of from 200,000 to 300,000 available and *reliable* troops of all arms be a dim vision of the future ; and though our national place in the world—our existence as a substantive military and naval power—or our effacement from the roll-call of puissant nations, hangs upon the chances of the hour in the meantime.

But the railway tasks to be accomplished in case of threatened or actual future invasion will in all probability be much more exacting and complicated than that of suddenly pouring down 100,000 men of all arms—their *matériel*, ammunition, horses, and food *upon some one point* of coast.

The high probabilities are that the invader would choose some worst defended and most convenient place for landing upon our southern or south-eastern coast of England; or for many reasons, as well as to shorten the actual crisis of the landing itself, would choose two (possibly more) points of coast, so related and near enough to each other, that the armies landed at each should effect a junction very soon after getting firm foot on land. Even were one of the two great divisions to fail in landing, and be beaten off for the moment, or be no more than a feint attempt,—to become real if circumstances favoured,—the diversion would be of immense value to the other division which had completed its landing. For our forces must remain divided—one part competent to watch the fleet and transports, still hovering, with their large force on board, off the coast; the other to engage the enemy. Hence, even with the south or south-east coast alone as the theatre of actual invasion, the railway task would not be single and simple; it would be to carry suddenly (after its tasks of concentration in the interior or up-country military districts had been fulfilled) two or more large armies to as many different points of these coasts direct; or to carry both, in the first instance, to one point, and then put its lateral or coast branches into requisition to carry off to the other threatened points whole army corps, with their *matériel*, horses, &c.; and these orthogonal railway transports must neither clash with each other, nor wholly shut up the civil or ordinary traffic along the same lines.

The rapid seizure of London, the getting its four surrounding rich and thickly-inhabited shires within the iron grip of requisitioning, is so paramount an object for the temporary (at least) paralysing of our national life, that most strategists would probably select the south or east coasts as the best, because the very nearest whence to march upon the capital. But a soldier of more original thought and hardihood might adopt a very different strategy; and while we were kept amused by demonstrations on the south, the actual landing in force might be made in the defenceless estuary of the Dee, or between the Humber and the Wash, or at both; whilst a third expedition landing in the Solway or in the Tyne, and seizing the line of railway between Carlisle and Newcastle, might hold that line where our island is the very narrowest, and so sever the country into three portions,

cutting off for a time all communication by land between Scotland and the greater part of England, and for which coasting communication, even by steam, would be a poor substitute. With such a plan, our lines of railway from the north would rapidly fall into the invader's hands, and the additional distance to reach London would not probably prove to make much difference to him in time; while Manchester, Sheffield, Derby, Nottingham, Birmingham, with their great centres of wealth, population, and industry, and with their important railway junctions, would be cut off from London in succession, paralysed and pillaged probably before we could give them more than partial succour. Even if we suppose that by their partial destruction (which might prove suicidal) we deprived the enemy of all use of the great trunk lines from Cheshire and Lincolnshire, we must remember that Chester is under 180 miles as the crow flies from London; or with the unlimited assistance from impressed horses and vehicles, which it would be impossible to prevent in our country, about ten days' march—not five days to London if the landing-place were in Bridgewater Bay, or elsewhere in the Bristol Channel. The railway task would then become a truly formidable one, *viz.*, to move large masses of troops about the southern shires and coasts, under the worst and most difficult circumstances of sudden and unforeseeable orders; and at the same time, or so directly following as to come to the same thing, to transport northwards the great mass of our army, to meet the invader's force at the earliest moment, and as far as possible from London.

With this the ordinary traffic in our thickly-inhabited country must be to a great extent carried on. London and its surroundings are mainly fed by rail. With a population as great as that of all Scotland, it would starve before many days, were all railway traffic with it totally suspended for military purposes. The same, *pro tanto*, with many other of our great manufacturing towns and their surrounding districts. Indeed, these facts cannot but appear elements of power to every strategist who looks into the problem of our subjugation. They present means of compulsion so great, that in an island thick-peopled as is our own, and so dependent upon daily work for their daily bread, with no agricultural resource to fall back upon, as are millions of our population—we may admit that

the savage saying of Alaric, "The thicker the hay, the easier mown," would literally apply to us.

Everything, therefore, we repeat—the landing in force and good order once effected—would depend upon our being able to meet and to overwhelm our invader before he was half a week established on our soil; and assuming we had the army to do this, everything depends upon the railway system to enable that to be effected. The invader we must assume *tam Mercurio quam Marti*; with perfect intelligence, an ample system of spies—no hard matter to provide, circumstanced as we are—fully provided, ample in force, fleet of foot. If we are to let his graves tell his and our descendants of his temerity, our force must be as ample—our fleetness in moving it like lightning.

But a still more embarrassing case may arise, and especially if evil luck should bring America to number amongst a coalition of our enemies. The invasion of our own shores might be simultaneously accompanied by an invasion of Ireland, or Ireland alone might, though not probably, become the theatre of invasion, with a view to its disruption from England. The old military maxim with regard to Ireland was that in the event either of insurrection or of invasion, it should be treated as an enemy's country; and this was really acted upon in 1798 and 1803.

Such is, however, no longer politic, if possible. We must deal with the means of moving and providing for troops there, just as we should do in England or Scotland. The railway system of Ireland, and its circumstances and social relations, render these much more difficult than like operations in England. To these we shall presently recur.

In comparing our British railway system with that of Germany at large, or even with that of France, we readily discern that we possess in our own some not unimportant military advantages. All our main lines are double-tracked, with all the carrying power and safety that appertain to that, while long stretches of lines in both those countries are single; and though safety may be secured on such by telegraph and the block system, speed cannot.

Again, our haulage power and rolling stock are practically limitless. We possess, also, at various points on the great

lines, goods warehouses and loading appliances of an extensive character.

Our great lines also reach the sea at various points, where they are provided with wharfs and landing appliances, by which, so long as we retained even partial control over the coasting steam navigation, maritime communication might be made to work in with that by rail.

As respects some of the points treated on by Weber, also, we can compare most favourably with Germany, though there is less difference as compared with France.

The system of railway officials, servants, and working is practically uniform on all our railways; we all speak the same language; the system of signalling is very generally the same; so that it may be said (though not rigidly or without exception), uniformity prevails in the working details of all our English and Scottish railways. The vastness of our traffic at all times, both in passengers and goods, also gives us some elements of advantage in meeting a sudden demand for great military transport, inasmuch as on most of our more important lines all the officers and functionaries are more or less accustomed to sudden inundations of a traffic always large, and requiring great skill to manage. The great question for consideration is, how far is all this skill in ordinary management—all this skilful labour—all these appliances—capable of being turned over at a moment's notice from the traffic of peace to that of war? Any delay in this conversion may make it all worthless. Captain Formanoir, in his capital lecture on "Railways in Time of War," delivered at Liège in 1870, quoting Staff-Major Crousse's narrative of the campaign of 1866, gives us an example in the events of which Hanover was the theatre in 1866:—"Rien n'y était préparé pour la mobilisation, et malgré les plus grands efforts, il ne fut pas possible de regagner le temps perdu; tous les sacrifices que le pays s'imposait depuis si long-temps en vue de la défense nationale furent inutiles au moment décisif." What a lesson—capped by the extinction of Hanover as a kingdom which followed!

The rapidity and degree of effectiveness with which, then, our immense railway resources could be suddenly turned over to the purposes of war, and with the smallest amount of disturbance to their ordinary functions, depend to a very great

degree upon how completely the railway managers, from the top to the lowest, come to understand the military, and the military authorities, from the commander to the sergeant, come to know the methods of the railway ; so that, when the “decisive moment” shall come, each already shall know what the other needs to do, and how it will be done. For this the “schooling,” if ever, must go on in time of peace.

It may be greatly doubted—to put it in the mildest way—that such mutual knowledge and understanding have yet been schooled into either our army or our railways. If not, then at the “decisive moment,” with all our power, everything would be wild confusion and impotence. By national temperament we are slow at picking up new things ; we have neither the thoroughness in the “thinking-out” faculty of the Germans, nor the rapid *coup d'œil* and facile organising power under new and unexpected circumstances of the French. Our traffic managers and their subordinates, though of matchless skill and practice in their ordinary routine, which includes, no doubt, occasional great gluts of at least passenger traffic, it may be feared would, in many instances, find themselves confused, hesitating, and wanting in method and decision, when suddenly called upon, urged, perhaps stormed at, to conduct an overwhelming military traffic to which they were new and wholly unused. If the head thus goes wrong, in the railway body all the limbs follow.

The prevention of this, or the best means towards it, is “schooling”—study beforehand in peace.

Our railways are private properties ; the manager's duties are primarily towards his company. It may be very doubtful what authority the military powers would possess of a legal character over the railways in time of war, though of course, as abroad, the real power over all the lines would pass over to the State at such a time, and obedience would be exacted, if necessary, by force. Still we pride ourselves on being a law-abiding people, and certain it is we don't like compulsion, and that work done under that is badly because unwillingly done. Hence every railway company and its officers and servants ought to know explicitly now in peace whom they must obey in war, and how far military duties must take precedence of civil traffic. In the hands of every railway officer and servant should be

placed a brief printed code of regulations and instructions for conducting military transports ; and, conversely, there should be a corresponding book of instructions in the hands of every officer, of whatever arm or grade in the army, enabling him to become familiar with the needs and methods of railway management, appliances, and traffic, viewed from the stand-point of his own profession. These class-books (so to call them) might be made part of military instruction, and thoroughness in the knowledge they would convey, one ground for military merit or promotion.

We are satisfied of the great need at present of such "schooling" on both sides. There could be found probably a good many able enough traffic and goods-station managers, who never saw a thousand men under arms in their lives, nor a battery of artillery in condition to take the field, and who have no more notion as to what extent and sort of rolling stock they would need to move a corps even of ten thousand, than of what would be needed to reach the North Pole on snow shoes. On the other hand, we may entertain more than doubts as to the diffused knowledge amongst the officers of the army of anything beyond the most casual and skin-deep sort as to railway plant, management, and capabilities, either ordinary or in relation to their own profession.

There are about *thirty* signals of one sort or another in use on our railways. Of these the semaphoric signals are, we believe, uniform on all our lines ; but let us just ask, how many officers of our army know what any one of these means ; what is the signal code ; how are the signals managed at great junctions and crossing stations, &c.? Nay, let us take the simplest case. Everybody perhaps knows that engine-drivers whistle "when something is in the way," but there are not less than six different signals by whistle in use. How many officers could tell what these are, or distinguish by ear one from another?

In the two scientific corps of the army there are enough of officers whose trained minds would rapidly pick up more or less of this sort of information when devoted to it, but at present, with the exception of some half-dozen engineer officers who have been from time to time connected with the railway department of the Board of Trade, and most of whom have thus obtained a pretty intimate knowledge of railway affairs, we

see no reason to conclude that such knowledge is possessed in the army at all. The "Aide Mémoire portatif" of M. Body, as adopted in the Belgian service, would afford a good basis for such a brief class-book officer, as we have referred to, applicable both to the railway and the military.

It would also seem a good measure to establish at our military academies a distinct professorship of railways in relation to war, good candidates for which might be found amongst the engineer officers of the Board of Trade as above. A like professorship in connection with our great army medical schools would not be amiss; for one, indeed the very next in importance to that of rapid transport of troops and munitions, is the railway duty of rapidly and comfortably carrying the wounded to the rear.

In this we are persuaded very much remains to be considered, thought out, and reduced to rule by the War Department. We have no special hospital railway carriages; we probably never shall have. They must, therefore, be improvised. Have the proper classes of carriages for this adaptation been decided upon? Are the details of the adaptation contrived, reduced to drawings, tried, made sure that they will answer, and models made available for the information, now in peace time, of the superintendents and managers of all the carriage departments of the railways, all the carriage-building shops in the country? This is the point that even the French and Germans seem to have been least efficient in. The wounded suffered greatly on both sides in 1870-71, for want of proper carriages and accommodation.

Then as to rolling stock to carry, and appliances to load and to unload, artillery and carriages: do our railway officers know the weights, sizes, adjuncts and conditions of safe carriage, with the accuracy necessary to know if the waggons that may be first available be really available at all? whether their floors be strong enough to stand the heavy pressure from the wheels of the guns, under the jolting of the road? or are our artillery officers enough of railway mechanics that, knowing the weights of their guns, they can decide if the floors, &c., be strong enough or not? If not, is either party *already* up to the proper measures to be taken quickly to strengthen them?

We have a goodly lot of horse-boxes, luxurious travelling

stables, fit for officers' chargers; but has it been settled on both the railway and military sides whether we have anything better than the open cattle-truck for the transport of the mass of artillery and cavalry horses; or what adjuncts can be afforded for the fodder and drink, and the comfort of these *en route*?

Our goods sheds, though at all great stations usually full to encumbrance, are well arranged for ordinary traffic, and the goods cranes ample in number; but is it ascertained how far these sheds are well or ill adapted—or how they should be adapted—to the loading and unloading of military *matériel* and stores? Is it not pretty certain that the bulk of the platforms in those sheds are far too narrow for loading guns and carriages, and that the bulk of the goods cranes are of too light scantling to bear the weight of a common field-gun, with its wheels and trail?

There are travelling cranes on most of our lines—a few, as on the London and North Western, of great power—and used for clearing the line after "accidents" of carriages, débris, &c. Such cranes travelling along with artillery transports might be made of great service; but their numbers are very few. Do the railway and army authorities know even how many, and of what classes, sweep, and power, exist in the country?

These are illustrations only, and taken almost at random, as regards railway "plant." They all go to enforce what Captain Formanoir and General Renard have so well put—the need of forethought and provision.

"Quelque faible que soit une armée, quelque complet que soit le réseau des chemins de fer, le travail de mobilisation" (in which transport is included) "doit être parfaitement co-ordonné longtemps d'avance; s'il n'en est pas ainsi, si tout n'est pas réglé jusqu'à dans le moindre détail, l'incertitude, le désordre qui en est la conséquence naturelle, entravent tous les mouvements." "Les troupes, hommes et chevaux, le matériel, les approvisionnements, &c., encombrent toutes les voies, et vont s'accumuler en peu au hasard sur tel point et sur tel autre."

To escape such dangers he proceeds: "Il faut des précautions infinies, un ordre parfait, médité et arrêté de longue main, afin d'éviter les frottements administratifs, les conflits d'autorité, la confusion et les collisions dans les déplacements nombreux

et fortuits que nécessitera le passage du pied de paix au pied de guerre et de ressemblement."

So much for the military side of the two great parties who must unite for the uses of railways in war. Then, as to the railway side, he adds: "Les officiers, les fonctionnaires et employés de l'administration des travaux publics, que la chose concerne, auront donc reçu longtemps d'avance des instructions détaillées sur tout ce qu'ils ont à faire dans les diverses éventualités de guerre. Alors seulement les chemins de fer pourront donner tout ce que les hommes éminents préposés à leur direction, promettent avec une fierté et une confiance si légitimes."

This necessary and intimate *liaison* between the army authorities and those of the railway, so forcibly put, causes us to view it in another aspect before proceeding to some notices on structural points. If these two great bodies—army and rail—are at the decisive moment to work well, there must be no divided authority, nor any doubt as to where supreme authority lies. That supreme authority must lie in the regular army; it can own no little *imperium in imperio*. Of what use then, we must ask, is the so-called "Engineer and Railway Transport Volunteer Corps?" or rather, how is it possible but that, in any real crisis of war, it must not show itself perfectly useless, or prove itself an element of mischief—a *tertium quid* of an indefinable sort, got in between the army and the railway authorities, and without any authority over either, unless at the risk and damage of those on both sides who would be really responsible?

The Engineer and Railway Transport Volunteers sprang into existence some few years back, out of the Council of the Institution of Civil Engineers. Rumour has attributed the armed birth, like that of Minerva from Jove's aching head, to the inventive ingenuity of the honorary secretary. It is certainly the most singular amongst all the oddities evoked by volunteering.

The honorary colonel is Major-General McMurdo, and the entire corps consists of thirty-seven members, all of whom are lieutenant-colonels, and with their commissions we may presume all dated alike, so that no one officer is senior to or has any right to command any other. Of these, 12 are civil engineers, including the honorary secretary; 15 are traffic managers, including one engineer; and 10 are builders or contractors.

The list records no captains, no first lieutenants, no second lieutenants.

Of the twelve civil engineers, most are of venerable age, and some have never had anything to do with railways. The traffic managers would have their hands full of their own work on their respective lines, and are scattered all over the kingdom; their assembly as part of this extraordinary corps, at its headquarters in Great George Street, we presume, has, therefore, probably never taken place; and if it had, *cui bono?* The lieutenant-colonels contractors and builders have, in part only, ever had anything to do with railway work; and it is not easy to see how their becoming lieutenant-colonels is to aid their building and contracting powers in war time in aid of the State.

The duties of this corps are stated to comprise the preparation of "confidential reports for the use of Government on the railway transport of troops and their supplies, or the destruction and reconstruction of railways; the improvement of natural obstacles, and the making of artificial ones to impede the landing or advance of an invading force; and on topographical matters connected with these."

Yet it is not confidential reports that are wanting—nor are new lights likely hence to be given to the existing skill of railway traffic managers—nor those who keep our lines in repair, and would be employed to reconstruct them; while as to their destruction, as Captain Webber, R.E., aptly says,\* military engineers are likely to know quite as much as civil engineers; and as to advising on the improving or improvising natural obstacles, &c., it must be admitted, this is the function of the scientific soldier, who ought to know most about it.

Now we confess to being unable to see anything, when soberly viewed, but mischief to come out of this curious military excrescence of the Council of the Institution of Civil Engineers. We fully comprehend that its functions in time of peace are to wear a uniform and to flaunt feathers at field-days and reviews, and imagine they are taken for field-officers; an innocent silliness that, as with so many more of the "brave volunteer army," as the title is by which it is usually toasted, may have its social uses and delectations for the wearers; but in the event of invasion—at the "decisive moment"—what are they

\* *Prof. Papers Royal Engineers.*

to do ; what are to be their duties and place ? Let us imagine the actual military authorities of our future *real* army in conclave at one of our great metropolitan stations, Waterloo, King's Cross, or Shoreditch, and with the actual railway authorities called around them, and orders being issued, and measures promptly being taken in obedience to these, for the transport of some large corps with all their paraphernalia, when the thirty-seven lieutenant-colonels, or some of them, arrive upon the scene. The army authorities must still be supreme, the railway authorities must obey *their* requirements as best as they can, but in *their own* ways. What are the lieutenant-colonels to do ? They dare not interfere with the army, whose officers, we may assume, would neither wish nor want their advice even as to the military side of the matter in hand. They cannot meddle with the railway authorities, for these generally rough-and-ready executants of business are too full of work, which they fully understand, to be chafed or bothered by volunteer advice, however venerable the source.

What must be the upshot ? That, *malgré* the silliness of the position they had assumed in peace, most of the thirty-seven (who, be it remarked, are, out of seventeen hundred members of the Institution, alone supposed to concentrate all its military and railway genius) would have good sense enough to hold their tongues and disappear.

There is a portentously big element of sham, conscious and unconscious, in the whole volunteer system ; and pity it is for our national weal that nobody in a position of authority has the courage to point out this disagreeable truth to the volunteers themselves and to the public in detail ; but this corps, the whole consisting of lieutenant-colonels, is surely the greatest of all. Shams are bad things anywhere, but here they are perilous to us as a nation—they produce ignorant public reliance upon a really rotten stick. There are, there can be properly, but the two parties here—the army authorities proper, and the railway authorities proper. Let the former perfect their plans and intended movements without interference : let the latter execute them without being meddled with by a third party having no proper authority at all, and less competent knowledge, either of military affairs or of railway traffic management, than either the one or the other respectively, yet thrusting itself between them both.

As to this corps in the event of war advising Her Majesty's Government directly, either its advice will or will not be taken : if taken, it is an interference with the proper military authorities, and likely to end in confusion ; if not taken, as is more than probable, it is empty wind, retarding business. And as to its imaginary important aid in war, in destroying and repairing our railways, we may, without discussion, take leave to doubt its value, or its ever being called for. Sappers and miners should know best about the one, navvies and foremen platelayers about the other. Such rough-and-ready practical work is not best acquired in a course of committee-room practice of the House of Commons, nor in laying out new lines, nor best directed by "the foremost engineers in the profession." General McCallum, and there is no more experienced authority, says—"The fact should be understood, that the management of railroads is just as much a distinct profession as is the art of war, and should be so regarded." We may add, that railway engineering, or railway contract construction, involves little or no knowledge of railway management, and none of the art of war.

Uncertain counsels spring from divided authority. In warfare, above all other things, one only and supreme authority is essential ; the wisest in the world have, for thousands of years, recognised this, and insisted upon it. Εἰς κοιρανός εστώ was Nestor's advice to the organisers of the Greek expedition. And to enforce this by a more recent and professional judgment, Captain Webber, R.E., in his "Notes on the Bohemian Campaign of 1866" (*Prof. Papers*, vol. xvi. p. 46), says—"Every individual connected with the railway department (in England, and in reference to invasion, namely) should be subject to military law, and the whole management should be under one officer directly responsible to, and in communication with, the commander-in-chief."

It is the inevitable misfortune of the railway system that there must be two parties to the directing of its use in war : why on earth should a third party be permitted to volunteer itself between both ? It is not thus by the wisdom or the meddling of thirty-seven volunteer lieutenant-colonels, nor by "confidential reports," that smooth and rapid working in the crisis of invasion can be conferred upon our military and railway

services, but by now in peace making both universally and thoroughly understand each other, by quiet and adequate instruction, noiselessly given to *every* officer in both services, but especially to those of the army as it now exists, inasmuch as, with a very few exceptions, they need it most.

We have most reluctantly referred thus to this Engineer and Railway Transport Corps. The position and prospects of our own country and of the world are, however, such, that silky phrases and complimentary reticence are not to be tolerated in a matter where our national glory, if not perhaps our very existence, is in question. It were devoutly to be wished that some one whose voice could command respect would point to kindred fallacies and self-deceptions in the national volunteer system at large.

Let us now pass on from the remarks made as to the plant of our railways to some considerations as to their structural works in relation to war transports.

In the sketch given of the arrangements adopted on the Continent as the results of experience for the embarkation of troops of all arms, it will have been seen how important an element to despatch and avoidance of confusion is ample station space, and covered in if possible, with ample width and length of platforms, and wide and easy ways of access to and departure from the station.

For many reasons it is most undesirable that any of the troops arrived at a railway station should be kept waiting in the adjacent streets or ways, for lack of room within the station; and vast space is required, if confusion is to be avoided and speed secured, even for the embarkation of very moderate numbers. The troops should all be able to enter the station, and halt within its courts or sheds.

On this point M. Body writes—"Ce première fractionnement doit préférablement s'accomplir dans les cours extérieurs, parce qu'il exige beaucoup d'espace, et un grand déploiement des troupes pour être promptement exécuté, déploiement auquel ne se prête pas l'exiguïté général des trottoirs. Nous ajouterons qu'il exige un va et vient de la part des chefs, qui est souvent impossible et même dangereux, le long des marche-pieds d'un train qui est le plus souvent pas complètement formé." He adds—"Du fractionnement général

opéré sur les trottoirs résulte en outre l'immense inconvénient de voir souvent des fractions qui ne peuvent prendre position vis-à-vis de leur wagon, qu'a la suite d'un repliement successif des fractions sur elles-mêmes, ce qui complique singulièrement les manœuvres, et fait perdre beaucoup de temps." Such are the evil results of want of space as regards infantry. But it is far worse as regards cavalry and artillery, the space required for unsaddling and preparing the horses of which for embarkation is far greater than even that for subdividing the troopers.

Most first-class stations on foreign railways are placed on or near the natural surface level ; it is unfortunate that so many of our terminal stations or great junctions are placed either several yards above, or sometimes below, the natural level. In either case, if the station space be too small, the troops outside are not only separated from those within, but cut off as to facility of communication by difference in level, all leading to confusion and delay. Three of our great metropolitan termini on the north of the Thames present pretty ample spaces and width of platforms, though none are on quite the natural levels. But these, the Great Western, the Midland, and the Great Northern, are just the lines likely to be of least strategic importance to us in invasion. The lines upon which the crisis would come with its full pressure are, in all probability, the Eastern Counties north of the Thames, and all the lines out of London on the south of the river. Now of all these lines there exists not one even moderately roomy, good, and convenient terminal station, except that of Victoria. The London, Chatham, and Dover line may be held as being there tolerably well circumstanced and provided for military work ; but the terminal structures of all the others, of the several lines converging at the London Bridge station, and of the South Western at Waterloo, are in a military point of view insufficient in space, inconvenient as to levels, and in arrangement simply execrable. The two very worst are Waterloo and Shoreditch, and what sort of scene the latter station and its purlieus would present in the attempt to send from it a *corps d'armée* has been sketched, not less truly than vigorously, by the author of "The Battle of Dorking."

We have already pointed out that the feats performed, and

duly trumpeted in the newspapers, at some of these stations on Easter Monday Volunteer Reviews, are nothing to the point. Packing off a few thousand additional excursionists, rifle in hand, and after days of notice and preparation, no more resembles the transport of a great army corps with its accompaniments, than the Easter Monday review itself is like the operations of a real army in war.

It will be said, however, Yes, our great metropolitan stations may be cramped, little, and inconvenient, but then we have our circular uniting lines, and we have numerous secondary stations, all of which can be brought to eke out the deficiencies of the main stations. Let us not repose much on this fallacy; many of these secondary stations are absolutely valueless for military uses upon any tolerably large scale, and whether so or not, such a subdivision and separation of the troops as would be needed to make them available would result in enormous delay, great confusion both in military and railway arrangements, and the high probability of accidents or collisions, throwing for a time the whole of a trunk line idle, and deranging or stopping wholly the transport. It may seem a bold suggestion, yet we venture to urge, that Government should require sufficient additional space and works to be provided at each of the terminal stations of the lines leading to our south and east coasts, or should construct one or more stations specially devoted to military purposes, and in short branch communication with all those trunk lines. If the former, the expenditure should of course be that of the State.

So much for the military accommodation of metropolitan stations. If we go along the several lines that debouch upon the south and east coasts, we shall find their terminal stations still worse. Can anything in a military sense be conceived much more inadequate and absurd as the terminus of a great fortified place than that of Dover? For miles the line itself is hemmed in between high cliffs and the sea, or in tunnels, and at last ends upon a contracted and encumbered plot between brick walls and the sea, and with shed room not enough for the convenient movement of even 1,000 men with *matériel*, or for the handling of cavalry and artillery at all. We might extend remarks of like character to the station accommodation, in a military sense, of almost every important point upon our

south and east coasts. At most of these there is no adjacent cover (sheds) to protect troops and horses while waiting, no matter how inclement the season or weather; at several strategic points, as at Folkestone junction above the town, there are practically no sheds or accommodation at all. But we must leave the survey in detail to the consideration of the military reader who knows these lines and stations, and who will pass in mental review their sizes and constructions.

Again, along these southern district lines there are few or no sufficiently long platforms at any of the intermediate secondary stations to admit of the easy and rapid disembarkation of large bodies of troops, nor any means at all for getting artillery and carriages unloaded. Temporary earthen platforms, it may be said, could at most of these places be rapidly thrown up, if necessity obliged troops to be there disembarked; but the enemy might make this impossible, and in any case a newly-formed platform of loose earth is but a poor appliance, and, in heavy rain, perfectly useless. We urge, then, once more that now, in time of peace, ample station sheds and platform space, long and sufficient disembarking platforms at all strategic points, and sufficient appliances for the loading and unloading of artillery trains and cavalry, ought to be (after general survey held, and plan formed and thought out) provided at both ends, and along each of our great lines leading to the points likely to witness the descent of an invading force.

Another point well worthy of thought now in peace is the probable sufficiency of our country common roads leading to and from these southern and eastern terminal stations. These would form parts of the flanking communications of our army. From their naturally flimsy construction and want of soundness of road material, and the desuetude of heavy road traffic since the use of the railway system, it may be feared that a great many of these roads would get so cut up by a few days' military operations, especially in wet weather, as to become impassable.

With our southern shires occupied by the invader, and our own forces facing him, even but for a few days, large trains of ammunition, of food and forage, and of various stores, would have to be poured southwards, and to remain more or less at points along the lines. We may inquire, then, are there any <sup>and</sup> sufficient long and safe sidings for these to stop upon, and

others for the location of hospital trains into which to collect the wounded and sick in progress to the rear? We fear not. In the American civil war it was found necessary upon 115 miles of one line of railway to lay down sidings within about eight miles of each other, and each capable of holding at once from five to eight long trains of stores or of troops. Again, do there exist along the lines leading to the south and east sufficient and sufficiently frequent supplies of good water to enable trains of cavalry and artillery, &c., to water the horses *in transitu*? Horses, especially young and freshly-trained animals, suffer intensely from the thirst induced by the nervous excitement of railway transport. Horses in civil life, carried along these lines in close horse-boxes, may have water with them, and suffer thirst less; and, moreover, are swept without let or hindrance from end to end of their journey in two or three hours. But in the case of cavalry or artillery transport the exigencies of the military conditions, or the state of the traffic or of the line itself, might oblige trains to remain for hours, or a whole night and day, somewhere on the line, and without the possibility of unloading the horses. Water is then for them the *sine qua non* for health and condition, or, it might be with many, for life.

Heavy trains, too, involve heavy drain upon the tender tanks, so that the engines might need replenishing with water after shorter runs than usual. Are there intermediate supplies of water and water cranes along these lines? These are far from exhausting the inquiries of this sort that ought to be entered upon, and the wants met now in peace, if we are to rest in confidence that in the dread hour of trial the railway, as part of our defensive armour, shall not fail us.

The establishment of some *one* uniform system of communication between the commanding officer in a train, the conductor, and the engine-driver, would be important on all our railways. Transport trains nearing the enemy may have to feel their way along for miles, perhaps in driving rain, or in obscurity of night or fog. At no moment of the transit should the military commander be cut off from issuing instant orders to those on whom the progress or stoppage of the train depends.

Ireland and its railways, in relation to war, demand some

special consideration. An invasion of that part of the kingdom now would not be attempted on some wild and rocky shore, as in old times at Bantry Bay or Killala. The descent would more probably take place in the mouth of the Shannon, at Waterford, Sligo Bay, Lough Foyle, or Belfast Lough, or in Galway Bay, which is within little more than 100 miles of Dublin, the intermediate line, if afterwards held as a military communication, cutting the island right in two.

The trunk railways from all these places converging upon Dublin—in fact, almost all the railways in Ireland—are trunk lines without lateral railway communications with each other, and not even connected with each other where they converge at Dublin.

Some of the lines are single tracked for considerable lengths; all are of one common gauge of 5 feet 3 inches. The traffic both of goods and passengers is small. There is almost no coal or mineral traffic, and hence the rolling stocks and haulage power possessed by nearly all the lines are small, and the supply of waggons especially defective for meeting any great and sudden demand. The passenger carriages do not afford any material increase of capacity, though larger than ours. The system of railway Direction is subdivided, cumbrous, and in the highest degree ignorant and ineffective. There are said to be about forty Boards of Directors for the few hundreds of miles of railway—many at variance with others, or about one director to every two or three miles of railway. The traffic being both small and simple in character, and not subject to great gluts, the traffic management is not in the hands of men of the generally able stamp of the corresponding officers in Great Britain. The country is not rich, it has few great centres of wealth, population, artisan skill, or of buildings of a character and magnitude useful for military purposes dotted over the country. Timber in balks or plank of fit character for improvising railway bridge or other works of restoration or of a temporary character are not to be found in any quantity except at the points of import. The goods sheds are few, small, and often ill provided.

For these and other reasons, while the distances along these trunk lines are considerable, and, therefore, their use important, whether to invader or defender, the service must prove limited

and difficult beyond anything likely in Great Britain. From the absolute want of lateral rail connection between the trunk lines even at their converging points at Dublin, as already referred to, the rolling stock of no one line can be brought upon another in aid of its own resources of the same sort. The gauge being different from our British one, no help in the way of rolling stock could be given, even were there time for it, by the transport by sea of rolling stock from this side of the channel. For all military purposes in meeting invasion, then, the Irish railway system must stand or fall upon its own capabilities, and under any circumstances, but especially should the invader be welcomed by the inhabitants, the railways would be probably of more value to him than to ourselves, unless we had such length of notice beforehand, and such knowledge of the invader's intentions, as would enable us to remove all the rolling stock from the ends of the trunk lines he should first reach, and to breach those portions of the lines themselves.

On the whole, the railway system of Ireland could not afford, at the best, anything like the same powerful aid, in rapidly meeting and crushing an invader, that properly belongs to our British railways if rightly " schooled " beforehand, so as to be handled to the best at the supreme moment.

A very few of the great terminal stations, as those of the Great Southern and Western, the Midland, and the Belfast to the north lines, are large and well covered, and provided with tolerably roomy platforms; but most of the stations, including some of the most important terminal ones at Dublin, are small, and in every way defective in all that military transports on a large scale stand in need of. Of course, while and in so far as we should continue to hold command of the seas around our coasts of both islands, and had steam transports and armed convoy ships still at our disposal, the military use of the railway system in Ireland would be less indispensable to us, though time would necessarily be lost in so far as it was unavailable.

But all that might not so happen; our transports and fleet might be all more imperatively wanted elsewhere, or the latter might have been scattered or destroyed. It is not by shutting our eyes to everything except the *couleur de rose* side of these questions, but by manfully regarding the possibilities of *the*

*worst that may happen*, that disaster is to be escaped, and safety plucked from the nettle danger.

It is needless to lay much stress upon prior preparations as to production and repair of rolling stock or engines to meet the destruction of a foreign invasion, beyond the best precautions to prevent the great railway shops for these purposes falling into the enemy's hands at once; unless in which event, our means are practically boundless, as are also those for the repair of trucks. It should ever be borne in mind, in foreseeing the conditions of a great invasion, that its final issue is almost certain to be an affair of a few days, at most of three or four weeks, within which either the invader will have been beaten back to his ships, or to surrender, or we shall be practically in his grip, by his having reached London, after which he can (for a time at least) dictate his own terms. Once around London with his forces, tolerably unhurt, there would be no need of bombardment or violence; requisitioning upon the grand scale, possession of some of the Government offices, the stoppage of food supplies, and the command to all the water companies to temporarily cut off their supplies, on pain of having their works destroyed, and within a few days, as the Roman system was said to have fallen by its own weight (*ruit sua mole*), so London, and with it for a time organised British Government, would fall by the mere mass and pressure of its starving and thirsty population.

Nor is it easy to see how, with even some weeks of notice and preparation, this could be materially altered or provided against.

Hence, and with the greater reason, is it that every preparation that can be made beforehand by help of our railways and in every other way should be made now in peace, to crush the invader before, or if not, directly after, he has planted his army upon our shores.

It follows also, however viewed or from whatever side, that speculations and preparations (at least in the south) for a prolonged desultory or even guerilla contest are not likely to be of much service.

Even were the invader's army only to hold us at bay for a time, retaining his temporary command himself or by his allies of the sea, he would soon be reinforced by a second band of invaders and assume the offensive, and become in the end

probably victor. Were he to lose command of the sea, or his ships be destroyed behind him, a second maritime expedition would cease to be feasible. The enemy would lose his true base, and though he could easily subsist for an indefinite period on the fatness of our land, and perhaps even supply more or less his want of military stores, still it seems most unlikely that he would not have to relax his grip, seek permission to withdraw upon terms, or, what is more probable, be compelled to surrender. But in any one of these contingencies the events must hurry on, and the whole drama be played out in a very brief period, and upon a very small stage, compared with the surface even of our small island.

The popular notion, then, which seems to be a little shared in by some few even of our military writers, and the acting upon which is declared one of the duties of the Engineer Volunteer Transport Corps, viz., the destruction and reconstruction of our own railways, which it is supposed may play a very important part in enabling us to resist invasion, seems not well founded.

Some reasons have been already given for this. Our lines leading to the invader's landing-places are of infinitely greater importance to us to preserve, especially at first, than to the invader to employ. He cannot destroy our lines beyond his advanced posts, and up to these they remain of use to us to the last moment, whilst within his lines they are useless to us.

It is always one of the gravest problems that can be presented to a commander, when and where he shall destroy a line endangered, but which the turn of events may make of great importance to his own plans after a few hours more; and no prudent general will give the order, at least for any such destruction as may be radical, or not admit of repair in a few hours, until after he has decided, 1st, that the destruction is necessary; 2nd, that the advantages to be certainly gained more than balance the evils that may probably result; or, 3rd, that while useful to the enemy, the line must become useless to himself for ulterior operations.

These questions would be nearly always asked under conditions of the invasion of our southern shires which would induce a negative answer; and, in fact, as we have already pointed out, after our first great army transports were completed, railways would be of very diminished importance to both combatants,

and of less to the invader than to ourselves. The immense scale and prolonged importance of alternate destruction and restoration of trunk lines in the American civil war between 1861 and 1865, so ably described in his Reports by General McCallum, United States Army, are wholly inapplicable to our case. The contending armies had each to move over vast distances from their bases to meet the enemy; their entire stores and subsistence had to be brought over these long lines.

Thus Sherman's army of 100,000 men and 60,000 horses and mules, &c., was supplied from a base 360 miles distant for a considerable time over one line of single-track way, and lying through the enemy's country. The possession and use of the line were vital to Sherman; its interruption or destruction equally so to the Confederates.

No wonder, then, that immense lengths were destroyed and repaired again immediately on this and other lines. In 1863 the Confederates totally destroyed at one swoop twenty-two miles in length of the Manassas Junction Railway, and throughout the war, in which more than 2,000 miles of railway were in military use, and about 2,500 skilled men employed by the United States Army alone in restorations, repairs, and transports, no less than 641 miles of new track were laid down, and about twenty-six miles, if continuous, of bridges reconstructed or repaired.

No such conditions can arise in our small country, either for invaders or invaded, nor could similar motives exist.

The American conditions to some extent exist both as regards Germany and Austria, where there are great trunk lines, with none parallel to them but after wide regions have been passed. This and the vast surface of both the countries have caused the official Prussian and Austrian regulations to be full of precise instructions and details as to the methods, &c., for destroying and for restoring railways, and caused the Prussians in 1866 to establish a special field corps of military railway men, analogous to the "Construction Corps" of the Americans, whose "Transportation Department" was with the former unnecessary, because in Austria the State railway officials are at once in war time under the control of the army. We should find ample materials for a repairing corps in the surveyors of way, the gangers and plate-layers of one or more of our great lines; and all that

would be needed would be to place these under the command of a competent engineer officer directly in communication with the commander-in-chief. On the other hand, as regards destruction of way, if ever decided upon, there can now be no doubt that it can be effected, if necessary, even for miles in length with little or no manual labour, and in very little time, by the detonative explosion of small deal boxes or canisters of gun-cotton placed under or upon the rails. This application of gun-cotton, or of dynamite in any of its forms, was unknown at the time of the American contest, or even in 1866 ; indeed, we are not aware that it has been previously proposed at all, however obvious a method.

The destruction of large bridges and viaducts upon our railways, as proposed by Captain Webber, R.E., and others, we believe would prove an unwise decision almost in every contingency, and might be of more serious after-detriment to ourselves than immediate hindrance to the enemy. The true plan of hindering an invader's use of our coast lines leading to the capital would seem rather to be to fortify them from point to point, by placing block-houses or small forts at both sides of the line, and at every few miles along its entire length. If these were made on the excellent model of the Prussian block-houses constructed for the defence of the Berlin and Görlitz line at the bridge of Kotbus, or of the Ems and Coblenz line at Ehrenbreitstein on the Rhine, the cost would be very small, and those lines of ours would become useless to the enemy until after all these fortalices had been in succession battered and taken ; while until then the entire lines would be available to ourselves, and if retaken would fall again into our hands uninjured, so far as we ourselves were concerned. A line of railway so provided would be, in fact, very much in the position of one which passes through a fortified place, or under the guns and ramparts of one. At any rate, all such wholesale destruction as blowing up viaducts and bridges, blowing in tunnels and the sides of rock cuttings, should be reserved for a *dernier ressort*. The practice of the French in this way in the recent war, though not without one or two cases of large result, chiefly showed how much and how irremediable may be the destruction of such works, and yet of how little use or value, though at vast pecuniary cost.

We have thus traced with a rapid pen the chief uses of

railways in war, the principles and rules for the conduct of great military transports, and the regulations for the embarkation and disembarkation of large bodies of troops, as adopted by all the great military powers of the world, after the most complete consideration and ample experience.

We have illustrated the relations to these that the construction of stations and rolling stock present, and pointed out the deficiencies of our stations for military purposes.

We have indicated the direction and the scope in which our railway system must be severely tried—namely, in the event of our being invaded—and have endeavoured to point out how the working of our British and Irish railway systems in such warfare would vary and depend upon the strategic views and operations of the invader.

And we have pointed out some of the many respects in which our existing position, as to the military authorities on the one hand, and the railway authorities on the other, is defective, and that if it remain so, our railway system must prove, at the moment of real trial, impotent, and probably a fountain of confusion and disaster. We have pointed out that two great parties must combine their efforts for the warlike uses of railways, viz., the army and the railway management at large; that if these two do not beforehand each understand, within certain limits, the business details of the other, as well as completely its own, the two cannot work together, and neither can fail in hampering and impeding the other.

We have pointed out that our traffic managers and railway management at large know nothing, theoretically or experimentally, of the conditions for the transport of large bodies of troops equipped for real war, and that the officers of our army (except half-a-dozen Royal Engineers perhaps) know nothing of railway affairs in detail—and we fear, as a class, very little about the military side of railway war transports, or even the broad relations of the railway system to warfare.

And we therefore urge upon our own public authorities, in the same way as Baron Weber has urged upon the military Governments of Germany (and been attended to by these), the importance, now in the days of peace still vouchsafed to us, of not only in several respects preparing the con-

structional works of and on our railways for our own special needs in a war of invasion, but of "schooling" now, to the respective knowledge of each other's business so far as we have pointed out, both our railway management and the officers of our army.

If not done now in peace, it will never be done; and if not done while yet it can be done, and should the disaster and humiliation of a successful invasion hereafter await us, nothing will add afterwards more intense point and bitterness to the vainly-given lesson than the reflection that, possessing the most complete and magnificent system of railway communication in the world for purposes of peace and of commerce, we nevertheless neglected, in the overmastering greed of gain, or in the apathy of self-indulgent wealth and repose, or in the mutual trickeries of party leaders pretending to statesmanship, to make the mighty instrument of locomotion also best fitted for our safety, for our victory, in war waged in defence of our own hearths and for our national existence.

Our argument throughout has rested on the assumption that England shall yet possess a genuine and powerful army, to be transported upon her railways.

The fulfilment of that looks as misty and far off now as ever, though the abolition of purchase is not without hopefulness, in gradually substituting for a vain-glorious race of ignorant and ludicrous popinjays, one of serious, studious, and well-trained officers, looking upon military service as the professional occupation of their lives.

There is far too great ground for fearing, however, that the organisation of a genuine army will be pottered upon and tossed about as a party weapon, until some day, amid their useless regrets and recriminations, the handwriting on the wall shall blaze forth—

#### Too LATE!

The Volunteers are, with the great English public—greatly ignorant of all that relates to war—a very popular body. It is a social heresy to say a word against them.

Nevertheless we will venture boldly to say that they can never be anything more than a most uncertain and unreliable element of even our defensive military strength, and absolutely

useless to enable us to sustain our national position abroad in support of allies or enforcement of treaty rights.

Weed out from it, were that possible, the elements of personal vanity, and the *agrément*s of playing soldiers at Wimbledon or elsewhere, surrounded by well-dressed women and the luxuries of wealth and peace; let those few of nobler motives and aims once be made to comprehend the military hollowness of the 300,000 riflemen that sound so formidable on paper, to see as it really is—this imposing panoply for national reliance—

“A goodly apple, rotten at the core,”

and the whole affair would crumble away to nothing. As matters stand, the Volunteer force is a national self-deception, and all the more mischievous because it serves to hide from the public eye the actual void and feebleness of our military position, even for our own defence. The first step of real and sound statesmanship towards the organisation of our future British army would be the total abolition of the Volunteer force—the next, the compulsory military service of every adult and able-bodied man in the State, with sufficient training to make real soldiers, able “to endure hardness.” All that is good in volunteering would then transfuse itself into that army of the nation, fit and competent to act with the army of the Crown, which under the actual circumstances of England cannot be dispensed with.

We might support the suggestions made in the foregoing pages by the expressed opinions of many other military and railway authorities in addition to those of Baron Weber.

“L’organisation des trains destinés à l’embarquement de la cavalerie et du matériel de guerre demande de la part des agents de l’administration des chemins de fer, préposés à leur composition, une intelligence parfaite du mécanisme d’embarquement de ces armes, et une connaissance exacte de toutes les manœuvres qui peuvent nécessiter les chargements et la formation des trains.”

The training for this must have been “prévus et réunis par une organisation spéciale tenue en activité même en temps de paix. Cette organisation spéciale dite de paix est essentielle, elle permet seule d’atteindre aux conditions préparatoires de ce mouvement stratégique—soit la certitude dans les calculs—

le secret des opérations préliminaires et la promptitude d'action."—(Body, *Aide Mémoire*.)

In his "Notes on the Campaign in Bohemia in 1866" (*Prof. Pap. R.E.*, vol. xvi. new ser.), Captain Webber, R.E., writes:—

"Previous to invasion, a well-devised scheme should be worked out . . . . with a view to preventing, if possible, any line in the country being used by the enemy;" and he recognises the necessity for forming the nucleus of an army railway department, and recommends the establishment of a course of railway instruction and practice at Chatham, and that staff-officers should have to obtain such knowledge.

It is true Captain Webber's thoughts principally run upon operations for the destruction and reconstruction of tracks; but that he only sees in a dim way, if at all, the far greater importance of training in peace the officers and the traffic managers to their combined duties in war, is only another fact added in support of the views we have adduced, as to how little either yet comprehends, or has even profoundly reflected upon, the uses of railways in war, as directly related to our own country. It may be greatly feared, too, or rather it is perfectly certain, that for want of any well-digested printed code of regulations to be studied now in peace as to our railway management in time of invasion, terrible confusion must arise from the ignorance or doubts of traffic managers as to whom they are bound to obey, and of military officers as to whom they have a right to command.

Such were the difficulties experienced in the American civil war, through the orders given, and sometimes enforced by violence, by corps or even regimental commanders, to interfere with railway operations or transports actually in progress, that on the 10th November a general order was issued from the Adjutant-General's Office, Washington, to the following effect:—"No officer, whatever may be his rank, will interfere with the running of the cars, as directed by the superintendent of the road."

How readily one may imagine some hectoring officer, in blissful ignorance of all such base mechanical craft as "traffic managing," and only resolved to obey his own orders according to his own view, commanding some of our traffic managers to

do something, on pain of being shot instanter, which the latter knows to be impossible without destruction of life or property, or incompatible with other tasks before imposed upon him, under equally formidable sanction.

There is but one remedy—each must have some clear knowledge of the other's business ; let that knowledge be possessed by both, and the Hector becomes a reasonable and articulately-speaking man, and the traffic manager no longer stands before him a dumb, though probably obstinate and duty-loving, animal, but becomes his coequal in cordially-rendered and effective assistance.

Such is in part, at least, the *gist* of this Introduction.

It will be recognised, we trust, that no strokes of genius, civil or military, no subjects for “confidential reports to Government,” in a word, no Utopias have been brought forward.

What has been suggested and urged is the very common-sense proposal that the tool should be really made and kept sharp, and fit for the work it may be put to ; that our railways themselves, their stations, buildings, plant, rolling stock, &c., should be rendered as well suited to the time of war as to that of peace ; and that those who manage for us all this so well in peace should be so instructed that they shall equally well manage in war ; thirdly and lastly, that our military and our railway officers should be trained in peace mutually to understand each other in war.

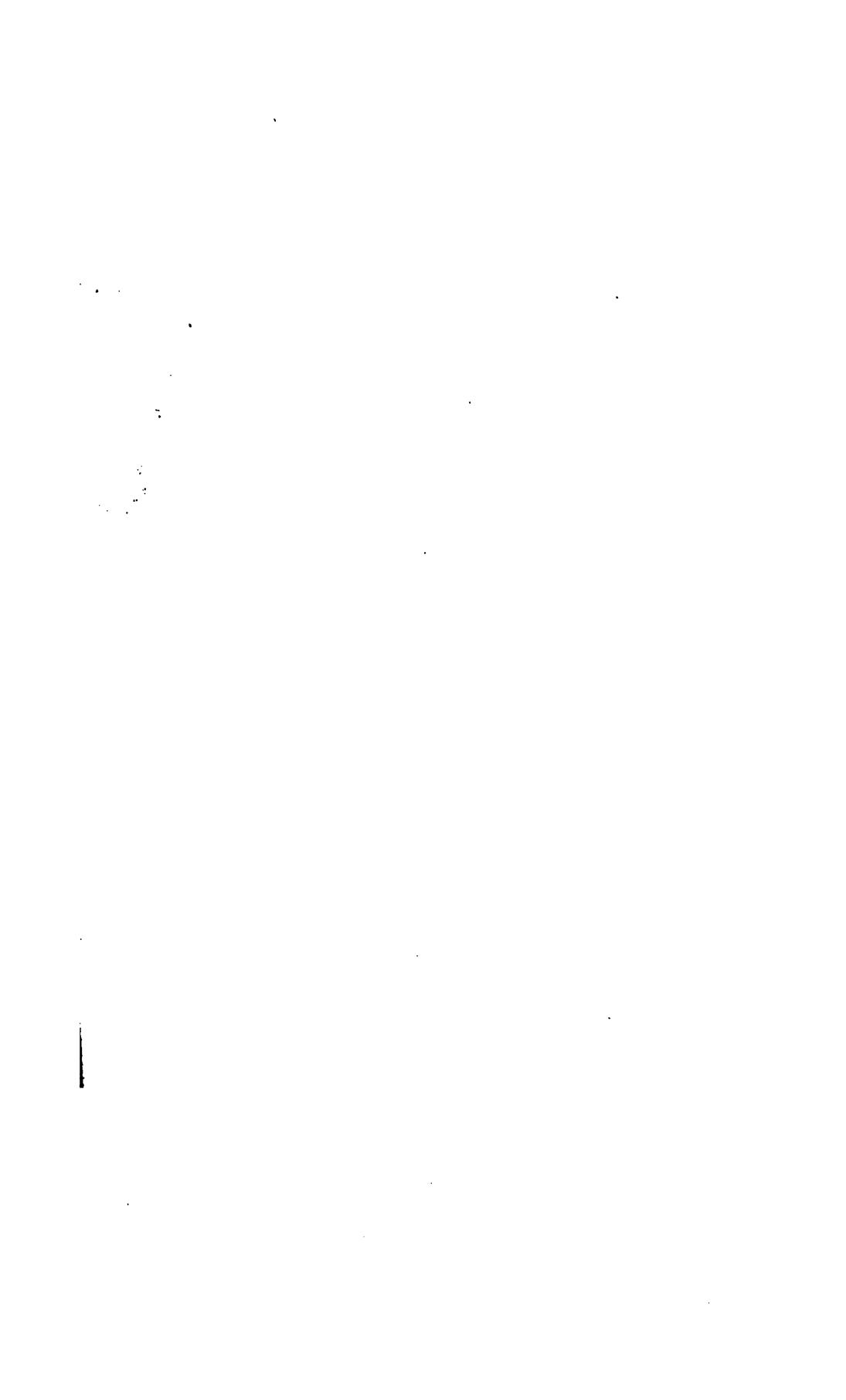
The subject is so full of import, and seems as yet so little to have attracted any large or intelligent attention, railway or military, in England, in whose technical literature nothing as yet on it has been published to our knowledge, that it has been deemed advisable to subjoin a list of some of the foreign works relating to it.

ON THE TRAINING OF RAILWAYS FOR  
WAR, ETC.

By BARON M. M. FREIH. VON WEBER.

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A TRANSLATION.



## TABLE OF CONTENTS.

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### SECTION I.

#### I.—DEFENCE-DUTY OF PUBLIC INSTITUTIONS.

	PAGE
Universal Duty of Defence . . . . .	68
Defence-Duty of Public Institutions . . . . .	68
The Training of Institutions for Defence-Duty . . . . .	69
Supposed Dangers . . . . .	69
Entrance of the Traffic Departments into Defence-Duty . . . . .	69
Their manifest Want of Training . . . . .	70
Preservation during War of the System used in time of Peace . . . . .	70
Violently-enforced Uniformity . . . . .	70
Elements of War Training . . . . .	70

#### II.—THE SECURITY OF THE WAR SERVICE OF RAILROADS.

	PAGE
Ideal Condition of War Traffic on Railroads . . . . .	71
Hindrances to the Attainment of this Condition . . . . .	72
Stages in the War Service of Railroads . . . . .	72
Commencement . . . . .	72
Increased Service . . . . .	72
Full Service . . . . .	72
Advantages of Progressive Succession in War Service . . . . .	73
Security of Railroad War Service . . . . .	73
Irregularities peculiar to Rail Service in time of War . . . . .	74
Causes of the Irregularities under A . . . . .	74
Mutual Function-knowledge . . . . .	75
The Want of Uniformity among Railway Institutions . . . . .	76
Impracticability of the profitable Study of Railroad Institutions . . . . .	76
Differences in the Construction of Conveyances . . . . .	77
Insecurity of Locomotive Nomenclature . . . . .	77
Causes of Irregularities under B (Blockade of Stations) . . . . .	78
Uniformity in the Local Management . . . . .	79
Mistaken Address . . . . .	79
Prevention of Collision (Protection of Stations during Blockade) . . . . .	81
Difference of Method in securing the Safety of Stations . . . . .	81
Differences in Telegraphic Apparatus . . . . .	81

	PAGE
Causes of the Irregularities under C (Inefficiency of Stations) Construction of German Stations . . . . .	82
Construction of English and French Stations . . . . .	82
Disadvantages of German Construction . . . . .	83
Superiority of the English Construction of Goods Stations in time of War . . . . .	83
Conveyances not designed for Through Traffic . . . . .	84
Conveyance of War <i>Materiel</i> . . . . .	84
Cranes and other Machinery . . . . .	84
Hindrance to the use of such Machinery in Germany . . . . .	84
Advantages of German Waggon for Man-transport . . . . .	84
Preference for English principal Stations . . . . .	84
The French and English System of constructing Stations for Passenger Traffic preferable to the German in time of War . . . . .	85
Difficulties in restoring Order . . . . .	85

## SECTION II.

## PREPARATION OF RAILROADS FOR WAR SERVICE.

Consideration of the Means to be employed . . . . .	86
The Efficiency of Railroads for Peace and War purposes almost always attainable in the same way . . . . .	87
The Measure of the Efficiency proportional to the Uniformity . . . . .	87
Meaning of Uniformity . . . . .	87
Uniformity the Foundation of Preparation . . . . .	87
Classes of Uniformity . . . . .	88
A, Uniformity of Construction . . . . .	88
Some kind of Uniformity necessary in time of Peace . . . . .	88
Uniformity in other Countries . . . . .	88
Technical Directions in Germany . . . . .	88
Executive Introduction of Uniformity . . . . .	89
<i>a</i> , Uniformity in the Construction of Design . . . . .	89
Peace Relations mostly considered in Design . . . . .	89
French Design . . . . .	89
Separation between the Passenger and Goods Service . . . . .	89
Rules for the Building of Stations especially useful in War . . . . .	90
The Want of any fixed Design in the Construction of German Stations . . . . .	90
Rules for the Construction of Stations . . . . .	91
<i>b</i> , Uniformity in the Construction of Carriages . . . . .	91
Decrease in the Number of Forms of Construction . . . . .	91
Special Carriages or Waggons . . . . .	92
Disadvantages attending their Employment . . . . .	92
Simpler Construction of English and French Waggons . . . . .	92
Advantage of Simpler Waggon Construction in War Service . . . . .	92
Construction of Men's Carriages . . . . .	93
Through Passage and Coupé Carriages . . . . .	94
Special Locomotives . . . . .	94
Advantages of Reduction in Variety of Type of Locomotives sacrificed to Efficiency . . . . .	94
Difference in opinion among Technists . . . . .	94
Construction of Locomotives . . . . .	95
Jointed Engines ( <i>Geleuk maschinen</i> ) to be avoided . . . . .	95

## CONTENTS.

65

	PAGE
Influence and Example of the State . . . . .	96
B, Uniformity of Railroad Languages . . . . .	96
$\alpha$ , Uniformity of Expression in Words . . . . .	96
Principle . . . . .	96
Misconception arising from Partial Comprehension . . . . .	96
Dialects of Railroad Language . . . . .	96
Speciality of Railroad Language . . . . .	97
Difficulties attending the Introduction of Uniformity . . . . .	97
Normal and Study Stations . . . . .	97
Glossaries and Indexes . . . . .	98
Designation of Functions . . . . .	98
Uniformity of Instruction to the Executive Officials . . . . .	98
$\delta$ , Uniformity of Expression by Signs or Signals . . . . .	99
Classes of Signs or Signals . . . . .	99
Telegraphed Phonetic Signals . . . . .	99
Signals . . . . .	99
Uniform (Dress) viewed as a Signal . . . . .	99
Appointment of Signal Writing . . . . .	99
The most Important Phase of Uniformity . . . . .	99
Signal and Telegraph System of M. M. v. Weber . . . . .	100
Confusion and Disorder prevailing in the Signal System of German Rail-roads . . . . .	100
Difference of Signals upon Neighbouring Lines . . . . .	100
Signal Forms, Objects, &c., upon German Railways . . . . .	101
Meeting of Railway Technists in England . . . . .	101
<i>Commission d'Enquête</i> in France . . . . .	101
Increase of Efficiency by Uniformity of Signals . . . . .	102
Signals—arranged in “Technical Directions” . . . . .	102
Energetic Efforts for the Introduction of Uniformity . . . . .	102
Plan for Universal Signalling on German Railways by M. M. v. Weber . . . . .	102
Method of Introducing the new Signal System . . . . .	102
Uniform (Dress) . . . . .	103
Uniform—the Badge of Service is a Signal . . . . .	103
Complicated Condition of German Uniform . . . . .	103
Disadvantages of Excessive Uniform . . . . .	103
Limitation of the Uniform System . . . . .	104
Austrian Badge System worthy of Recommendation . . . . .	104
Distinction of the Classes of Officials by Uniform . . . . .	104

## SECTION III.

## ORGANISATION OF RAILWAY WORKSHOPS FOR THE CONSTRUCTION AND REPAIR OF WAR MATERIEL.

Railway Workshops for the Construction and Repair of Locomotives . . . . .	106
Number and Distribution of Workshops . . . . .	106
Method of Training the Staff . . . . .	106
Uniform Machinery, Weights, and Measures . . . . .	107
Facility in effecting Proper Training . . . . .	107



## ON THE TRAINING OF RAILWAYS FOR WAR, ETC.

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THE meaning of the expression “training or preparation (*schulung*) of railroads for war in time of peace” may easily be misunderstood. It might be mistaken for the costly and difficult, as well as annoying, experimental trials of conveying troops and war *materiel*, the fruitlessness of which is as apparent to the officer who has studied the question as to the practical engineer; experiments which are consequently no longer in vogue. In a word, that signification has nothing to do with the question.

Happily, the preparation of railways for war is to be effected not by manœuvres, manipulations, and requirements which are useless in time of peace, but, on the contrary, by the very arrangements which they need for the most complete fulfilment of their proper task in time of peace, which are thus the aim of all enlightened administrations, though this frequently cannot be attained from the absence of sufficiently vigorous external control.

Nothing should be admitted in war which would injure the working of railroads in time of peace; yet we have to thank the overwhelming influence of the standing army of a great combined country for the introduction of such a uniformity of certain organs of railroad institutions as is equally beneficial to both the peace and the war vocations of the great instrument of the age.

In the introduction of this uniformity lies the essential element of the “preparation of railroads for war in time of peace,” the great importance of which the short duration of the

European war of 1866 was insufficient completely to exhibit. But the bright light of subsequent happier relations must not dazzle our eyes while examining methods which may be useful in darker times.

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## SECTION I.

### I.—DEFENCE-DUTY OF PUBLIC INSTITUTIONS.

IT is a universally acknowledged truth, deeply impressed on the consciousness of nations, that in the well-regulated State each individual has a peace as well as a war function, a duty of sustentation and one of defence. For each of these he ought to be educated and trained with corresponding carefulness.

In like manner most public institutions have a peace and a war duty, and it is solely from insufficiently realising our ideas of State life that we do not take this thought into account in the design and organisation of those institutions, nor provide for its permeating the public mind in the same way as the defence-duty of each individual citizen does.

This deficiency is naturally founded in the inherited disinclination of cultivated man to prepare for war in time of peace, to give military organisation to institutions of a specifically peaceful aim ; through long years of peace to look forward to the most distant possibility of war, and to introduce the spirit of military discipline and uniformity in cases where, for ordinary purposes, it seems not only unnecessary, but undesirable, nay, sometimes even injurious to the peaceful and proper development of those institutions. But this impression, inherited from our ancestors, who employed mercenary soldiers to fight their battles, is not justifiable in an age when State and army, and army and State (in Germany), mean the same thing ; where there is no activity, no power in State life, howsoever distant it seems from the functions of war, which may not assist and co-operate when the army is once in equipment for the field of war, and in which the certainty of victory, with all its advantages, is almost always on the side where the entire State, with the trained co-operation of all its institutions, thus enters the lists. Thus civilisation, by order and wise economy, produces

the strength and irresistibility in attack which, in former days, belonged exclusively to the fanatical assemblage of entire nations in their contests of religion and race.

When we propose in the organisation of certain peace institutions a regard for, nay, even an express training in, their functions as influenced by, and for supporting the operations of war, we of course do not allude to any kind of military drill. The genius of modern war administration, which possesses a far higher range than that of former times, has confined drilling to the province of the direct executive of officers and soldiers, and by its means has transformed the fighting masses into those lines of force which the directing spirit stretches out and draws back like so many gigantic limbs; while the training in organisation we propose is only designed to fit them to comprehend with greater facility, and to execute with greater uniformity, the functions required from them during war, and in the reciprocal intercourse of military intelligence or duties to render mutual agreement more secure than hitherto.

A mistaken view is also held with regard to the dangers which threaten the development of the peace functions of civil institutions when we extend our attention to their duties of war. For, on the one hand, the science of the economy of battles, as we may well term the modern art of war, has developed itself with such rapidity and perfection up to the height of the science and arts of our time, that far from obstructing, it is rather adapted to draw after it other branches of science and practice; while, on the other hand, the introduction of that uniformity which is indispensable for service in war, frequently outweighs the dubious advantages which might be supposed to accrue from the desultory pursuit of apparent progress in the uncontrolled freedom of individual isolation.

Of all civil institutions the services of the transport department of the State are peculiarly called into requisition in time of war.

The case is closely parallel to the recalling of men from their furlough and retired lists to engage in active service. As the danger of war increases, their civil occupations give way to their military. But the great difference between the simplest furlough man or soldier of the reserve recalled to service, and the transport departments at the moment of entrance upon

their war duties, lies in the fact that the latter during long years of peace have received no kind of training for their service in war.

They form at the critical moment merely an outwardly connected reticulation of lines, of which the administration and *personnel*, in form of arrangement, in outward signs of functions, in instructions, signals, &c., use on each line a language almost completely unintelligible to its neighbour.

The ancient political divisions of Germany are thus caricatured in the sovereign ordonnances of about sixty different administrations of its railroads, each of which endeavours as much as possible to distinguish its line as a separate whole from that of its neighbour.

*Yet nothing can be more advantageous for the effective utilisation of railroad establishments in time of war than the arrangement that their methods of conducting business in time of peace, the system to which they are accustomed, and which is familiar to their personnel, should require as little modification as possible for the purposes of war.*

The carrying on of war above all other things requires the most extended uniformity in the arrangements of its institutions in every department.

But the sudden and violent enforcement of this uniformity at the moment when the services of the transport departments are put into requisition for war purposes, in lieu of the uniform, practised system familiar for years and become almost second nature to the officials, replaces the old system just as badly as would be the case if, in carrying on the ordinary business of these establishments, military officials were suddenly introduced into the offices of the usual functionaries. No matter how well trained and instructed these might be, they would only possess a portion of the capability of the long-trained men.

What we mean, then, by "preparation of railroads for war in time of peace," is, in the first place, the introduction of uniformity in the business arrangements and regulations which are required for the war functions of the transport department within the territory of all militarily-connected States.

And the second element in this training is the establishment of one current system common to, and equally understood by, all branches of the military departments and by all classes

of railway functionaries ; whilst under the present relations almost invincible obstacles are found when the officer conducting transports encounters, in the course of a day's journey, half-a-dozen different signal systems, three or four different arrangements of trains, managements with just as many different regulations with regard to the despatch of trains, distinction of officials, their limits of function, &c., &c.

The aim in view is that the explanation or meaning of signals, the functionary distinctions of officials, the regulations with regard to the order and despatch of trains, &c., should be as familiar to the military as to the railway officer, and *vice versa*.

Loss of time is thus avoided, the military officer and the railway official understand each other without circumlocution, and by mutual concessions the service is rendered in the best manner, and those fatal accidents prevented which always occur when commanding officers and obeying servants are at home only in mutually unknown departments, and consequently speak different languages. In order to remove an apprehension that we frequently find among clever engineers pursuing their vocation with success, devotion, and a sublime exclusiveness, viz., that the introduction of such uniformity will be injurious to the development of the railway system itself, we need only say that this uniformity should be introduced by careful selection under equally guarded forms, and that the energetic progress of the railway system is just as much in the interest of war as in that of peace.

Lastly, in the worst cases, happily of rare occurrence, traffic systems must, in order to fulfil one of their holiest duties, be prepared, if need be, to sacrifice a portion of their development ; just as the individual citizen devotes a portion of his time to his military training in peace, and the whole of it to war if invasion call him forth.

## II.—THE SECURITY OF THE WAR SERVICE OF RAILROADS.

We must regard such a condition of railway traffic for war purposes, in which everything is carried on with the same exactness and the same precision of agreement in all the elements of traffic as in the regular and ordinary peace system, as purely ideal. Such a condition is seldom or never attainable during the period of the utilisation of railroads for war purposes :—

1st. Because the objects for transport, their management and modes of conveyance, as well as the times and rate of despatch, are unusual.

2nd. Because the authority of the railway officials is no longer proportionately regarded or supreme.

3rd. Because interruptions and hindrances to the carrying on of the traffic must arise from these influences, just as unusual conditions more or less produce them in time of peace.

The war service of railroads presents three successive phases increasing in efficiency.

a. When the war service is carried on during the continuance of the ordinary traffic, by the addition of increased numbers of transport waggons to the usual trains or by the despatch of extra trains, without interruption of the usual routine. In these cases the authority of the railway officials remains supreme; the influence of the military almost always consists in making known their wishes—it is simply an alliance between the two.

b. With an increased demand for the services of the railway in the cause of war, a portion of the peace traffic must be discontinued in favour of transportation for war purposes. Attention to the peace traffic then falls into arrear. The times of stopping and the rules for the despatch of trains must give way to military requirements, and the railway officials receive a great portion of their instructions from the military. Still for this form of service time-tables ought to be arranged and observed as far as possible.

c. The third stage is entered upon when the ordinary traffic has to be completely discontinued, and the entire efficiency of the railway service devoted to war purposes. Supreme command is now in the hands of the military authorities, and the advice merely of the railroad functionaries is taken, and solely with regard to the safety and the utilisation of the services of the establishment. The executive falls into the hands of an irregular admixture of military and engineering powers. In this form of railway war service, manifested at the seat of war during and before or after every great concentration or battle, the greater portion of the arrangements with regard to traffic fall into abeyance, even though they have been worked out with the object of sudden expansion in view. The safety and efficiency of the establishment now depend almost entirely

upon the facility of comprehension between the authorities of each service, the army and the railway, and their acquaintance with their mutual organisations. In this stage the railroad executives are necessarily frequently removed from their own peculiar spheres or proper lines, and employed on lines of which the system, rules, and regulations are unknown to them.

*It is always a great advantage for the successful performance of railway military service when these three stages can gradually succeed each other.*

Fortunately this is generally the case,\* as the first phases appear with the first preparations for war, and at the critical moment the last. This gradual increase of military service with proportionate decrease of civil service secures the inestimable advantage of studying the co-operation of the military and engineering powers, of learning their most suitable distribution and organisation at a time when order in some degree prevails, of training them for their mutual employment and duties before the destruction of all system takes away the ability to do so.

A remnant of this training remains and operates beneficially even at a time when masses of men and *matériel* pour down over the roads, a conjunction which the most careful study of war organisation cannot prevent.

Upon this training, in combination with corresponding business arrangements, depends the comprehension of the instantaneous demands for service, and upon this the safety and the effective utilisation of railroads at such a moment.

By the security of railroad service we mean the prevention of all extraordinary occurrences by which the transport of masses by rail may be impeded or delayed. By the strict regulation of railway service in time of peace, interruptions to traffic can only arise from elemental influences or unavoidable injury to the road or machinery. Malicious injury, from its rarity, need not be taken into account when considering interruptions to rail service in time of peace.

The preservation of order is effected by the co-operation of the

\* This is just what, in all probability, would *not* happen in our own case if invasion were attempted. The full strain must, if it is to be of any use, come at once upon one or several of our trunk lines; the greater, therefore, the reason for our being prepared with instant rapidity to pass from the traffic of peace to that of war.

reciprocally intelligible *employés* in a completely organised system without interference one from another, and with complete topographical knowledge. But during war it is very different, for, in addition to the specific dangers incidental to organised railway traffic, the service has to contend with irregularities peculiar to a time of war, as well as with the operations of the enemy.

The irregularities peculiar to war service are of three kinds:

A. Delay from the unsatisfactory arrangements of the service, and for the employment of rolling stock.

B. Temporary interruption to traffic from the crowding of transport masses at the stations, or at sidings.

C. Unsuitableness of the stations and conveyances for the required military service.

To these irregularities, peculiar to railway service in time of war,\* we may appropriately add a fourth,—

D. The tedious rate of reparation, on the part of the ordinary peace service, of damages in the way and works occasioned by accident or hostility.

An investigation of the causes of these irregularities ought to lead to means for their redress.

#### A.

The unsatisfactory arrangements of the service, and the misemployment of the rolling stock, &c., originate, in the greater number of cases, from—

- a. The absence of sufficient mental comprehension between the military and the railway officials.
- b. The strict limitation of the efficiency of individual railway authorities to their own lines only.
- c. The ignorance of the entire staff of each line with regard to the detail and service regulations of the neighbouring lines.
- d. The impracticability of employing certain modes of carrying on business beyond the circuit to which they belong.

\* It is true that similar irregularities appear, under exceptional circumstances, in time of peace; but we must not regard them as peculiar to rail service at that time.

The value in practice of mutual intelligence being established between military and railway officials has hitherto been far too slightly regarded. Demands for services from the military authorities impracticable from the very nature of railways in general, or the nature of the existing lines in particular, have called forth confusion and ill-will on the part of the railway authorities and conductors. On the other hand, the latter have frequently declared services to be impracticable which were really not so, and all this from the circumstance that the two parties in the transaction have too little insight into the nature and mechanism of their respective callings, and regard their powers more as contradictory than co-operative, so that they do not and cannot work together.

If, on the contrary, the nature of railway service, with its modifications from the nature of the ground, the locality, and the organisation of the service, is apparent to the military officer, at least in a general way ; if he comprehends how the same amount of transport must be differently performed if he passes from a level line to a mountain line, from a double line to a single one, from one where the signal and telegraph system are in use, to one in which these organs of safety and intelligence are destroyed ; if he can judge of the capability of stations, the length of track, and arrangement for the lading, ordering, and passing of the trains, &c., he will, with this knowledge, and his orders framed in accordance to it, come much sooner and with greater facility to an understanding with the railroad executives than if his commands had to be rectified by assertion and contradiction, frequently carried on under the influence of excited passions, or attempted to be enforced by violence.

The railway official also who has some acquaintance with military science, who understands from practical experience and inspection, not confined to his own line, the capabilities of lines and stations in a military point of view, will, at his first transaction with the military authorities, enter sooner into an understanding with them than if he were deficient in this knowledge, and will find himself in a position to co-operate, and not be coerced.

General military service in Germany has greatly advanced the spread of the knowledge of military organisation. The

uniform extension of military forms to the whole of the great combined country has been still more advantageous.

The North German railway official who has completed his term of military service knows, no matter whether it relates to Königsberg, or Frankfort-on-the-Maine, or Leipsic, or Wiesbaden, that a squadron of hussars consists of so many horses, a battalion of infantry of so many men, that the battery will require for its transport so many carriages, and for its lading such and such arrangements.

It would not be difficult for him to acquire also such a knowledge of the equivalent regulations, commands, signals, &c., in use throughout the entire army, as would be requisite for the execution of his duties in the war service of the railway.

On the other hand, the military functionary, amid the confusion of railway institutions and arrangements, is far more unfavourably placed. Every regulation which becomes known to him relative to the organisation of the system, the arrangement of the stations, the uniforms of the officials, the signals, is only of use for a distance which he may pass through with his troops in an hour or a few hours; then comes another line, with other and often very different regulations, so that he would have to study an encyclopædia before he could address each railroad administration in its own tongue, as it were, in reference to its own institutions, &c.

It would be of little use for the military functionary to consult, relative to the institutions of the neighbouring railways, the administration of the railroads which he has just traversed, and whose district he must quit for others. The administration of German railways might permit his accidentally discovering, though without official guarantee for the validity, those rules and regulations of neighbouring railways which have no reference to peace traffic, whilst it might be important for him to know the most private arrangements of the directorate.

There is no central point in Germany where the military functionary could study the regulations of all German railroads, and the information collected with difficulty by journeys, local studies, and inquiries, &c., may become worthless in the course of a few weeks or months by alterations made in the arrangements of some of them.

Even were all these modifications reported as made at a central point, it would still be impossible to keep before one's mind the actual condition of the great complicated whole at the moment required. The like difficulty arises with respect to the arrangement of rolling stock.

In no country of the world do we meet with such theorising relative to the construction of rolling stock as in Germany; for every kind of goods to be conveyed a particular carriage has been designed, excellent in its especial domain, but of little or no use for any other purpose. The continual passing and repassing of empty waggons, with useless wear and tear of the lines and great complication of construction, is the consequence.

These technicalities have greatly hampered German railways; even the most explicit order for waggons is a puzzle to the officer appointed over rolling stock, as well as to the railway officials when the waggons are required for special purposes.\*

The same word embraces the name of a number of different kinds of carriages, one of which is the best adapted for a particular transport, the rest perhaps totally unsuitable. The same name distinguishes waggons of completely different construction on different railways. The names of the different kinds of carriages frequently give no idea of their construction. Suppose, for instance, that conveyances for horses were required, and an order written for a number of open transport waggons distinguished as "provided with strong floors," there might possibly arrive at the appointed place, and at the required time, the right number of waggons certainly, but not one of them available, because, for example, they were constructed with side-doors, closed by a long bolt from above, so that no horse could go into them. Or we may suppose for the conveyance of guns open waggons with strong floors being sent, or for mountainous travelling open waggons with such broad wheels that the curves could not be passed without risk to life. A single mistake of this kind, and under present relations we cannot conceive war traffic exempt from mistakes, renders a whole station and a

\* Although there is much general uniformity in the rolling stock (for goods) of almost all our lines, it may be feared that the nomenclature employed for the various classes of trucks or carriages is not free from certain differences, and hence more or less possible ambiguity, taking the whole length and breadth of Great Britain.

number of engines and conveyances useless at an inestimably valuable time, and may traverse completely a great combined transport arrangement. These circumstances are peculiarly annoying when, as frequently happens in war time, the locomotive power of one railway is required to render service upon several other lines; for neither the ideas connected with the words "express train," "luggage train," "passenger train," "mountain engine," "engine for mixed service," and so on, nor those connected with their business nomenclature are the same, and they may be doubtfully understood from line to line. With reference also to the construction of the locomotives, German construction is so scientific that the greater number are only available for the one purpose and the one railroad for which they are constructed, and the designation conveys exclusively the idea of the special case.

A luggage engine on line A is an engine for mixed service on line B, and conveys express passenger trains on line C. The engines of line D could not run without risk on line E on account of the construction and wheels. All the officials on lines A—E understand the words to relate exclusively to the locomotives familiar to each of themselves, so that an order, according to the designation, nay, even if it were possible to give some further description, may often lead to irreparable mistakes.\*

## B.

The crowding of stations is another feature in the vexatious and annoying, and often fatal occurrences, which result from the carrying on of business under unusual relations such as are demanded by the war service of railways. It frequently happens from the want of a sufficiently watchful and systematic despatch of trains to branch, cross, or terminal stations, that the rails become so covered with carriages, and the functions of the sidings so paralysed by cross trains, that it is absolutely impossible to arrange the traffic in the required way, and start trains for their destination in orderly and quick succession.

\* On almost all our great lines a certain uniformity and adherence to a few types of engines have been adopted; and on some, as, for example, the London and North Western, the engines have, under the able direction of Mr. John Ramsbottom, been reduced to a very few types, each consisting of parts so identical in form for each engine as to be mutually interchangeable.

This happens especially when different military and railway service authorities simultaneously declare that the traffic belonging to each of their particular districts is of paramount importance, and press for their despatch to a certain locality. It follows that they all meet in a block-up at the same place, the orders frequently coming from quarters where they have no idea of the locality, and yet the business arrangements must be obeyed, no matter what the consequences may be.

These blocks-up also occur from the delay of trains, the missing of the crossings, the want of water for the engines, defects in the rails and works, and mistakes in the arrangements or signalling, or mistaking signals.

Blocks-up can mostly be avoided by an intelligent consideration of the whole case, embracing the whole of the co-operating powers; and only by this means and by patience can they be remedied. Violent measures always make the matter worse. The condition of a crowded railway station resembles the child's game of spillekins, in which it is necessary to remove each straw without disturbing the whole mass.

It is generally necessary to send back trains from the blocked-up stations to those lying nearest which are free, and to take advantage of their rails and sidings. Sometimes room can be made for the ordering of the transports by packing together a number of carriages in an open space; but it is indispensably necessary in such circumstances that supreme authority should be given to some one experienced person, that the executive be performed according to his orders with the greatest exactitude, and that the agreement between the military and railway powers be complete and faultless, and be implicitly acted upon.

This is only possible when the military functionaries are freed from the danger of mistaking the business of every railway official with whom they have intercourse, *e.g.*, insisting upon giving the goods manager employment which is the duty of the carriage conductor, demanding information from an overseer which only a railway manager could give, besetting the inspector engineer and controller with questions which belong to a different department, or, what is worst of all, being driven from Herod to Pilate, and wandering about

without any counsel or plan, endeavouring to remedy the matter by issuing commands which, from the possibly violent severity of their sanction, only or for the most part increase the evil.

This will always be the case while the service insignia or uniforms of all the functionaries are different on different railways, when the military officer, in the course of his day's journey, sees one hour a train conductor wearing the same badge which the next hour he perceives on a station master, and from what he observes in one place, mistakes a simple overseer of way for a director engineer, or is tempted, as by his dress he often might, to consider a railway official as some military man.

The case becomes still more complicated when the officer in military command, with regard to the same service, must telegraph to-day to a district engineer, while yesterday he had to do with the chief engineer; when the same business belongs in one place to the department of the traffic manager, and in another to the railway inspector or some other officer.

A single despatch received by the wrong person, or sent back as unofficial, may occasion a station block-up, to say nothing of the case when the entire organisation of a railway is unknown to the military officer who wishes to prevent or remove a block-up, and consequently not a single question or inquiry reaches the right official directly or in the quickest manner (many, indeed, are totally lost), because the address is not to be found in the nomenclature of that railway. For instance, if any one on a Saxon railway wrote to the engineer of the line (Ban meister der Strecke), his communication would have as little chance of being directly received as if on a Prussian line he addressed himself to the engineer of the works (Betriebs Ingenieur), or wrote from Bavaria to the postmaster on the North German line. He would find that his despatch would not reach the hands of the person for whom it was intended.\*

\* These German difficulties as to the addresses, &c., of the right officials upon other lines, would be far less, for obvious reasons, amongst us; but it is equally certain that in war time, that is to say, with invasion imminent, or having taken place, such difficulties, and with probably disastrous results—certainly with delays—must occur until such a code of regulations and instructions shall have become familiar, both to the railway and to the military systems, as shall enable every officer in either to know precisely to whom he should address himself in every probable contingency.

The first and best measures to be thought of when a station block-up occurs are those which will tend to ward off dangerous collision with other trains.

This is partly prevented by sending messages to the neighbouring stations to delay trains there, or send them back to a greater distance, partly by cutting off the communication with the station.

The first method is only practicable when telegraphic communication with the neighbouring stations has not been destroyed, and is in full working. Half-comprehension is more dangerous than none at all, and even when the telegraph works well, the known methods for the protection of the station ought not to be delayed, so that accidents from any unforeseen cause may be prevented; for even when there is no question of the loss of life or limb, the injury and destruction to the rails, works, and rolling stock should be avoided, as rendering the block-up still more difficult to be removed.

The military functionary, the *employé* of another railway, who has to direct these measures upon such an occasion, and who, perhaps, a few hours before at a similar case had found at his disposal the most effective means for the protection of a station, apparatus for signalling separation, with the distance signals (*drahtzug bewegung*), and well-organised practice in the use of explosive signals for the same purpose, may possibly find himself completely at a loss at the next place, as the administration of the railway with which he is then occupied, though in the same country as the first, or bordering or joining in upon it, has neglected the introduction of this important means of protection from "higher technic" or motives of economy.

That the wisdom of railway administration with regard to these measures cannot be relied upon before the training of the civil and military functionaries for railway war service shall have been effected, is apparent. The conductor is here, as in most other cases where it is necessary to utilise the material of different railway lines for the same purpose, completely in the dark relative to the nature of the means next at his disposal.

The differences between the telegraphic apparatus in use on various railway lines is a less important obstacle. The Morse apparatus, with all its arrangements of alphabet, &c., is to be found at the principal stations, although modified in its con-

struction, writing off by perforation, by colour, &c. (Schlagschreiber, Farbenschreiber, &c.), for general application ; and most people who have learnt to use the Morse apparatus are able, with more or less skill and rapidity, to demand and receive information—on some lines especially. For communication with the small stations apparatus of another construction are used ; and the sending messages brought by the Morse, by re-telegraphing on these other apparatus, is always attended by imminent danger of misconception.

Under all circumstances blocks-up of stations are to be numbered among the most delaying and dangerous accidents which are occasioned by unusual press of traffic upon railways, and can only, by a clear insight into the existing means of protection, be prevented, or, if they occur, remedied without risk or delay.

### C.

German railway stations differ very essentially in the principle of their construction from those of other countries. The connection of the trains, the arrangement of the carriages, the changing of the waggons from one rail to another whilst the carriages and engines are moved backwards and forwards by sidings, are peculiar to them. It is manifest that, in order to effect this moving backwards and forwards, the lines must be freed from carriages standing on them ; so that often hundreds of carriages and waggons must be moved over great stretches of rails for the purpose of liberating a single waggon out of a long train. The rails at stations in France, England, America, and Belgium are traversed by ranges of turn-tables leading to the luggage platform, the goods stores, and the crane machinery ; and by means of connecting rails, these enable almost every carriage to run on the desired rails, and to take its place in the train, without shoving off the other carriages or changing very far their position. They permit one of the number to be taken out, and allow the lading of the carriages and arrangement of the trains to be carried on in several places simultaneously without hindering the work anywhere, as is the case at German stations, and cannot be avoided, owing to their construction. The English system secures the most complete utilisation of space ; the turn-plates and rails can be introduced

into corners of the station, which would not allow the German plan, with its rails and sidings (Weichen).

Connected with the English system we find a greater number of platforms, in each of which the gross amount of lading capability for beasts and war *materiel* is less; but it is manifest that, with a number of *short* platforms, from which access to any rail is open, much more can be accomplished in this respect than would be the case if the sum of the lengths of the short stages were united into a few large ones, to which access was only possible by the shunting aside of large trains.

The development of the principle of the construction of German stations is rooted in certain theoretical speculations which hinge upon the supposed danger of the cutting through of the rails by the turn-plates, upon the difficulty and tediousness of arranging trains with men or horses, and especially the advantages of having carriages of such huge dimensions that the turn-plate system is supposed to be impracticable.

Practice has proved the error of these predictions, and demonstrated that the risk incurred by the use of the opposite system of sidings (Weichen), and the rapid moving backwards and forwards by engine power of great carriages or trains, is tenfold greater than the turn-table system. German railway stations require, for the carrying out of their principle of construction, such dimensions as render the oversight thereof, and the effective utilisation of the rails and adjunct arrangements so impossible, that, in spite of the immensity of space and length of rails, every unusual increase of traffic—from fairs, festivals, &c.—produces such irregularity that business is more or less put a stop to. In German railway stations, with equal area and in equal times, less traffic can be carried on than in those constructed according to the system of our western neighbours. The same faults in construction which lead to the interruption of the civil service of railroads, and prevent the effective utilisation of time and space, must in time of war become far more distressing, and must render the carrying on of business still more difficult and uncertain. But with increase of traffic at the station, the danger of block-up diminishes in almost geometrical proportion as the capability of the station itself increases.

The difference in the construction of the conveyances on German railways, especially of those not intended for through traffic on other lines, but so used in time of war, hinders free manipulation at outlying stations, and further diminishes their capability.

The most tedious and difficult service required during war time is the conveyance of war *materiel*, guns, carriages, ammunition, food, forage, &c.

Our western neighbours are greatly assisted in this work by various and effective mechanical contrivances—cranes moved by hydraulic, steam, or hand power, and other lifting and moving apparatus—with which their stations are provided, and which incredibly increase their capability of making the most of space and time.\*

But German stations must, except in a proportionately very small degree, do without this assistance; the system of covered waggons prevailing in Germany (in France, England, and Belgium waggons are generally covered with tarpaulins easily removed) to a great extent limits the use of machinery for the loading and unloading of carriages to a minimum, and the stations are relatively poorly provided with the necessary appliances.

It does not mend the case to say that in time of war many hands are available, for there is frequently no room in the stations for their employment; and every additional hand leads to increased confusion.

On the other hand, it would appear that the German station and goods-waggon system, with the long platform running at the side in the one, and the firm roof in the other, were decidedly advantageous for the loading and transport of men and horses.

With regard to waggons this is generally the case, for covered carriages are superior to open ones for the conveyance of bodies of men; but we can only partially admit the statement with respect to the stations, especially as the principal stations constructed on the English and French system command a far

\* It by no means follows that these appliances, however well adapted for ordinary goods traffic, are equally well suited to economise time and space in moving military *materiel*, artillery, &c.; indeed, for the latter, much of it is certainly useless, as at present existing upon our British lines.

more extensive traffic of this kind than the system so greatly liked in Germany, where the one long platform is used for the departure and the arrival of trains.

The principal stations for passenger traffic according to the French and English system, a few of which are to be found in Germany and Austria, have generally several long platforms under one roof, which protects large bodies of men from the weather, and these platforms at terminal stations open on a cross one, giving room for a considerable number of trains, so that the departure of one can neither hinder nor delay the arrival of another.

What we require is the conveyance of such numbers of persons, and the employment of as many trains at our principal stations, where several platforms are properly to be found, as in London, Paris, and some of the stations in Vienna.

These arrangements, so suitable in time of peace, are equally available in time of war, so that the advantage of assembling a number of men in an enclosed space protected from the weather, and arranging them in trains independent of each other, is secured.

It is not to be contradicted that with regard to the suitability and capability of stations for war service, those of our western neighbours are decidedly preferable to ours, and that by careful study of the construction of the French and English stations, and by gradually extending the use of their principles so far as they are compatible with German relations, many advantageous hints may be gained which will increase the efficiency of German stations in time of war, as well as facilitate their powers in time of peace.

#### D.

The causes which produce the first three difficulties in the war service of railways co-operate in delaying all work which tends to the restoration of the rails and other matters which have been injured by accident or with hostile design.

All difficulties of comprehension arising from differences in the nomenclature of the various objects, implements, parts of the roadway, &c., the variations in the designation of the employments of the functionaries in the routine of the service

departments, the distribution of functions, become painfully manifested at the scene of the accident, when it is necessary to give orders to the officials and *employés* on foreign railways with regard to the repairs, whether those be of the carriages, implements, rails, sidings, or the like.

These difficulties are increased by the formalities, perplexities, and mistakes occasioned by the transmission of telegraphic information by means of apparatus which vary in construction.

Trains conveying men or material may be delayed by unusual signals, difficult to be explained, and frequently diametrically opposite in form and meaning to those previously in use and well known, and in the very work of restoration on foreign railways, the orders, the object, and function designation of the strange officials may not be understood at all, or what is worse, mistaken.

The danger of block-up is increased by these misconceptions, and by the increased traffic at some particular place caused by trains being sent to the rescue; so that in war, in many cases even of neglect of precautions, supreme authority placed in the hands of one person, and the services of an unlimited number of men at his disposal, would not be able to counteract the influences of the aforesaid difficulties, and accomplish the restoration of the rails and machinery in the same time as it could be effected during peace.

Malicious injuries or hostile operations are left out of the question, being completely beyond the province of calculation until the facts are known, and so the problem as it were for the first time stated.

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## SECTION II.

### PREPARATION OF RAILROADS FOR WAR SERVICE.

HAVING understood the difficulties and hindrances which the technical construction, organisation, and administration of the integrant parts of the German railway system oppose to its effective utilisation for war service, we proceed to consider the means and method by which the efficiency of railways for war

purposes can be increased without injury to their efficiency and progress in time of peace.

Happily, in this consideration we shall soon arrive at the knowledge that, almost everywhere, approach to the attainment of the one aim leads to the attainment of the other, if we leave the prejudiced impressions of some private and Government railway companies out of the question, and do not mistake the carrying out of isolated subjective opinions for the effective development of the whole to perfection.

The measure of the utilisation and control of the powers of a great mechanism composed of many independent elements, like the German railway system, is almost proportional to the uniformity of its construction and institutions. The army itself supplies the most obvious example of this truth.

But this uniformity as regards the railway system must not be misunderstood.

It would be extremely incorrect to wish to re-systematise and new model the whole railway system. This would cripple its vital peculiarity, the accommodation of the traffic to its circumstances and progress. A railroad is not such, irrespective of wherever it is situated and whatever it transports. A secondary line which forwards daily two passenger trains and a few goods trains with proportionate frequency must be treated, in respect to the construction of its line and machinery, official administration, signalling, &c., very differently from a trunk line with a great through traffic; a line winding through mountains requires a very different arrangement from a line running through a table-land; but the necessity of these differences is no hindrance that, for example, "red light," when used as a signal, should upon all railroads convey the same idea everywhere, that the insignia or uniforms of all functionaries should be the same, that the same term should distinguish the same thing everywhere, that every carriage be constructed to travel upon every line of its own gauge; and with uniformity in such sense, and with the consequent facility in the control and management of railways, their efficiency in time of war increases, and therefore the preparation of railways for war service, with the aid of some other elements, is founded upon the introduction of such uniformity into their departments.

The directions in which we should endeavour to introduce

uniformity in organising railroads for war service without detriment to their efficiency for peace service are two, which we may designate as

- A. Uniformity of construction.
- B. Uniformity of language.

Uniformity of construction embraces

- a. Uniformity of plan and system.
- b. Uniformity of rolling stock.

Uniformity of language embraces

- a. Uniformity of expression as to terms.
- b. Uniformity of expression by signals.

#### A. UNIFORMITY OF CONSTRUCTION.

The uniformity of construction which is usual upon railroads in connection with each other has already been shown to be indispensably necessary to traffic in time of peace; for without it the most painful complications would arise, presenting obstacles to the transit of the trains, and hindering inter-provincial and international intercourse. In France, Belgium, and England, uniformity has arisen from the practical minds of these nations, and has attained a high degree of perfection, especially in France, where but a limited number of large railway companies, understanding each other thoroughly, have the direction of the whole; indeed, there uniformity has received such a systematising, if I may be allowed the expression, as is unfavourable to the development of improved construction.

About sixty administrations of German railway companies in the beginning of the year 1850 caused a project for the uniform construction of German railroads to be drawn up by a commission of the most eminent railway technists, and submitted to a general assembly of men of technical science. The project thus elaborated, with the title "Technical Directions relative to the Construction and Business Arrangements of Railroads,"\* is excellent, and has had great influence in the desired way; but these "Directions," being merely emanations from a company without executive control, are wanting in force and legal sanction, so that here and there railway administrations

\* "Technische Vereinbarungen über den Bau und die Betriebseinrichtungen der Eisenbahnen."

with the sense of their own power, and technists full of their own well-weighed opinions, break through the prescribed limits, deviate from the "Directions," or decline to carry them through from motives the reasonableness of which, in comparison with the importance of the desired uniformity, is highly problematical.

Were these "Directions" enforced by the authority of the State, and the railway administrations compelled to introduce uniformity, there is no question this would be justified by the importance of the relations between it and the railway system, even at the cost of a material sacrifice. The exercise of a certain reasonable compulsion would not only be justified in their enforcement, but be welcomed with satisfaction by the more enlightened railway administrations.

It is conceivable that, in face of such relations, when the highest interests have to be consulted, such as the defence of the country or the exchange of provinces, not only must control over construction be submitted to the State, but a right be admitted to appropriate certain privileges of railroad companies in the same way as the individual is obliged, if need be, to give up a portion of his time and profits of his labour to the State.

#### *a. UNIFORMITY IN THE CONSTRUCTION OF DESIGN.*

In laying out railways, the exigencies of traffic, the relations of business, and the fitness to the localities of the work in time of peace, are solely considered.

It would, in most instances, be easy to take into account in those plans the conditions by which the characteristics requisite for railway service in time of war should be fulfilled without injury to their fitness for the fulfilment of their duties in time of peace.

The French, those masters in practical organisation, have elaborated schemes for the construction of their subordinate stations, according to the importance of each with reference to passengers, manufactured goods, and products traffic, and unwillingly deviate from these schemes; on the contrary, they frequently sacrifice other things for the sake of preserving uniformity of plan, because they find that advantageous for the administration and carrying on of business.

There is one paramount ground for this, viz., that the passengers, manufactured goods, and products services are well

separated, even in subordinate stations, and numerous complications are avoided which arise from a different arrangement.

When these services are conducted together, no rational system in the management of any one branch can be carried through, because the demands of one service hinder and restrict those of the other, and the increase of one has a prejudicial effect upon the management of the others, especially if the locality require enlargement or alteration.

But if this carrying through of one uniform system in the construction of stations be of advantage in time of peace, its value is still more apparent in time of war, when it may be of the greatest importance to know *a priori*, when one has to look for localities for a certain object, what is the extent of the accommodation in platforms, rails, stores, covered spaces, sheds, &c., at a goods station; the rooms available for offices, quartering, or hospital service at a passenger station, and so forth.

In any systematically-arranged plan it would just as little occur to the manager to inquire at a passenger station for storage room to shelter men, materials, and horses, or to send there with this object, as to reckon upon the assistance of cranes and platforms; and, therefore, the march and transport to the stations chosen can be pre-arranged far more rationally and with more economy of time, in the light of this pre-existent knowledge of what they will afford, than if their designation gave not the least notion of their construction, capacity, and arrangement.\*

Though the plan for the arrangements of all subordinate stations (for principal stations it is impossible to devise any general plan as to details) cannot everywhere be adhered to, yet the German stations are so completely void of any regulation on general principles that it is evident to every technist who studies the question, whether he be more or less skilled and experienced or more or less educated, that without the least possible injury to the intended aim of the buildings, a certain direction might be given to the existing ideas of their con-

\* The printed code of regulations and instructions recommended in the Introduction to be prepared and placed in the hands of all railway and military officers should contain a schedule of reference to every station in the kingdom, describing briefly the appliances, area under cover, length and height of platform, &c., viewed from the point of war traffic.

struction by means of general commands, from which there should be no deviation except through some physical necessity, and then only with consent of a higher authority.

Rules can be made for the laying out and arrangement of the principal business buildings and apparatus connected with them, their distances, extent, the arrangement of the coal and water stores, the workshops, the number and minimum size of the requisite turn-tables, sidings, and platforms, which may be here and there a little more than the locality demands, but in most cases may be adhered to with advantage, and may be agreed to by both the railroad and the military authorities, good-will on both sides being taken for granted.

The connoisseur in railway systems will not cherish any illusion on this subject. The regulations must be drawn up with much forethought, limited to generalities, for the carrying out of rigid maxims in detail in the plans of railways is attended with as much difficulty as expenditure of time and money. It often involves gradual reconstruction and great transformations. But just as little can he avoid seeing that the absolute want of any rules for the regulation and arrangement of the places of business of our railways has impaired their efficiency in peace as well as in war, just as much as the want of higher aims in the laying out of the German railroads themselves, and the divisions among the administrations, have hindered the complete utilisation of these great lines of transport for peace as well as for war.

#### *b. UNIFORMITY IN THE CONSTRUCTION OF CARRIAGES.*

It is easier to introduce uniformity in the construction of conveyances than in the construction of buildings, and to prove that a diminution in the variety of forms now used would not only be useful in time of war, but highly advantageous in time of peace.

As we have already mentioned, the profound and systematising German mind has invented a number of transport vehicles, by means of which every species of transport is conveyed with complete security. The utilisation of the carriage for the particular transport, and the protection of the object conveyed, are excellently considered, so that they completely fulfil their aim.

There are special waggons for coke, coal, peat, stone, iron, corn, squared timber, timber in round logs, lime, sulphur, straw, hay, swine, oxen, poultry, horses, &c., &c. ; some with fixed sides and roof, some with movable wooden roofs, some with movable or immovable sides, some with doors in front, some with doors at the rear, some with rail partitions, some with tarpaulin or leather loose covers, &c., &c. ; each different from the other in construction and arrangement.

Unfortunately these exquisitely perfect carriages are, in most cases, only available for their own particular purpose, so that they must return empty, and during a great part of the year are not in use. Thus the weight hauled to profit is not more than 25 per cent. of the entire weight of the carriages, and they are in actual use only fourteen days in the year, and standing useless in the sheds or workshops 351 days. The possibility of constructing a universal luggage and goods waggon adapted to all purposes of rail transport has met with very little consideration, though our practical neighbours have pointed out the direction by which the desired simplification can be attained.

A glance at the French and English goods waggons shows that the principal one in use is the open waggon (lorry) with movable solid sides, of moderate length, and wheel-frame and length of base of such construction as will answer for all lines, and that can be manipulated on the ordinary turn-tables. Each waggon is provided with a good waterproof tarpaulin or india-rubber tilt, with which it is covered when carrying goods which require shelter. This tilt is rolled lengthwise, and attached to the waggon with rings, iron pins, or chains, in such a manner as will allow of its being used for other purposes.

By means of these waggons, every kind of dead traffic can be conveyed, and a utilisation of the rolling stock effected with which our special waggons cannot be compared, whilst the haulage of dead weight and the resistance of the air in transit are diminished by the absence of boxed-in roofs, and every facility is offered for lading and unlading by cranes or other machinery.

By the predominance of these waggons, which are available for almost all purposes, the military man in time of war can under most circumstances reckon upon a large number of vehicles with the construction and use of which he is previously

acquainted, and will not be likely to be embarrassed by the arrival to him of a number of vehicles unsuitable for the transport he requires, and therefore worse than completely useless to him.\*

Waggons with boxed-in roofs are decidedly superior for the conveyance of troops, and in some cases horses also, particularly in winter time, and therefore should be provided in sufficient numbers, being indispensable for peace service also; but uniformity in size and construction should be attended to in these carriages in order to render their usefulness general. The prudent manager of war transports will always endeavour to provide himself with waggons which to-day will serve for the conveyance of ammunition or wheelbarrows, to-morrow for horses and men, although with discomfort to the latter, and which can be loaded and unloaded with the assistance of all the mechanical apparatus at hand.

It is not too much to say, with reference to the use of carriages for the conveyance of men in war service, that they should be constructed with the same wheel-frames as would permit them to run without risk upon all lines of the same gauge within the limits of width of those gauges, and be manipulated on turn-tables of small dimensions, say not exceeding 4 metres diameter. The slight increase of shaking and vibration injuring the repose of the journey, occasioned by the use of the shorter wheel-base of these vehicles, cannot be compared with the importance of the extension of their efficiency and the avoidance of accidents that are likely to occur when waggons with long wheel-bases, and laden with troops, are stopped at the frontier or limits of such lines as by reason of narrowness of gauge, clearance or sharpness of curves, they cannot run upon without risk.

\* However generally this is true as respects the rolling stock of our own lines, cases can be readily imagined, by any one conversant with the actual classes and builds of carriages upon several of our lines, in which great inconvenience and delay might arise.

Coal and coke waggons upon the Great Northern, the Midland, and some other great lines, are rectangular open-topped boxes, well adapted for certain war traffic. But upon many of the lines in the north-west and north-east of England coal and coke waggons are strange narrow-bottomed, deep, curvilinear-shaped boxes—the descendants of the old colliery “corves” of a century back—which are perfectly useless for transport of anything but coal or coke; yet these all go by the same name, and a traffic manager at the south might telegraph for coal waggons, and get from the north these waggons useless to him for any war purposes.

The next question is not irrelevant—whether carriages with a passage right through them on the Swiss and American plan, or the coupé carriages, are best adapted for the transport of troops. The advantages of the more rapid filling and unfilling of the latter, and the diminished risk in case of accident, are almost balanced by the facility of supervision, of feeding, &c., during the journey, and the advantage in conveyance of the sick or wounded offered by the former.

If the march of mechanical science has invented a special conveyance for every kind of transport, this fact is, in a much greater degree, true as to the construction of locomotives ; and, in demanding locomotives applicable for every line and for every species of traffic, we must admit that each kind of train upon each individual line can best be hauled only by a particular class of locomotive.

We called this multiplication of designs the result of the march of mechanical science, which has influenced every pursuit, and which now teaches the exact contrary to the principles held a few years ago, which aimed at uniformity of construction for all the locomotives upon one and the same line. The service has, in fact, altered with the development of traffic ; and the difference between express, passenger, goods, and mixed-service engines should be even more strongly marked, in order rightly to fulfil the demands of each. The *maximum of effect and security* can no doubt only be obtained by the construction of special locomotives for each special purpose.

But reason and judgment now inquire whether this *maximum efficiency*, with its slight *overplus of gain* compared with *good medium efficiency*, is really such an advantage that all the advantages arising from a reduction in the number of the various constructions of locomotives should be sacrificed to it.

This question might be answered in the affirmative if the opinions of technical experts were unanimous as regards the means by which this *maximum efficiency* can be secured. But one engineer requires for an express engine free-moving, heavy, centre driving-wheels of great diameter, without coupling, in order to obtain great speed with slower piston reciprocation. Another places his driving-wheels, unconditionally and always, behind the fire-box, according to Crampton's system, considering this the only safe construction. A third couples the

driving-wheels, and gives great diameter with great expansion to the cylinder, in order to start and stop energetically and quickly, and to overcome accidental resistance from wind and weather, and considers the true principle of an express engine to reside in this power. One gives six, eight, or even ten wheels to his goods haulage-engine, coupling them all together ; another maintains that engines with four wheels only are best, and advocates increase in number of the engines themselves according to necessity, &c.

Yet, with all these differences, the unprejudiced technist perceives that railroads which have no fast through traffic service can do with one, or at most two, classes of engines, and that but very few require three classes. Practical results of real importance are obtained by the decrease in the number of different constructions, if the convictions of the locomotive engineer will permit him to pay for the advantages of simplicity and uniformity in the service at the price of the expenditure of a few pounds of additional fuel per mile now and then.

Except for some unusual service one class of express engine, with short boiler, coupled wheels of 5 to  $5\frac{1}{2}$  feet in diameter, one pair being placed behind the fire-box, having large cylinders with good—*i.e.* variable—expansive power, large fire and heating surfaces ; and another class of engine for goods haulage service, with very great heating surface, and six coupled wheels between the fire and smoke boxes, will suffice for every description of traffic upon hill and plain lines of railroad ; while for mountain lines, with severe gradients and sharp curves, four-wheeled locomotives for all kinds of service, with the assistance of a few six-wheeled coupled assistant or towing engines, similar in construction to the goods haulage-engines of railroads of the plains, are sufficient. Articulated engines (*Gelenkmaschinen*) transmitting the piston power by link-work, and bogie engines of every description, are to be avoided for quick service, on account of their want of adhesion, great weight, and the danger produced by it.

Simplification in the construction of locomotives, and generalisation of their efficiency, are inestimable advantages in war service, when it frequently happens that strange lines are passed over, and the locomotives are driven by strange engine-drivers, who have little or no acquaintance with the conditions

of the way. It could not then happen, as in the war of 1866, that engines which had drawn a large military train upon a level line could scarcely draw a small portion of it upon the next hilly line attempted to be passed over, and that neither the railroad engineer of the department nor the traffic manager, upon receiving information relative to the engines sent to him from another line for certain descriptions of transport, could form any idea of what he would be able to do upon the next line he came to.

There is so little danger as regards life and property in the simplification of the construction of locomotives, that the influence of the State—even its control to a certain degree, but especially the example of the State railroads themselves—could scarcely be considered objectionable, if employed to promote in time of peace a reform so valuable in time of war.

## B. UNIFORMITY OF RAILROAD LANGUAGE.

### a. UNIFORMITY OF EXPRESSION IN WORDS.

To communicate with each other by means of language, we must first attach precisely the same idea to the same sound, word, or sign. If no idea be connected with the word or sign of the other, it is hearing or reading an unknown tongue—it is unintelligible; but if the word convey to the hearer or reader an idea different from that intended by the speaker or writer, it is Babel. We have *misconception*, with all its consequences; and the nearer the ideas approach to each other, the more dangerous may be the misconception, and the more difficult to explain.

The technical language spoken by the servants of the German railroad companies has almost as many dialects as lines and administrations, and the terms are not influenced by the provincial dialect in use in the locality. The servants of neighbouring lines frequently do not understand each other at all, or take up the wrong meaning if no explanation can accompany the term. This great evil is of less importance in time of peace, when only the neighbouring stations are concerned with each other, for their patois is soon reciprocally acquired; but it becomes far more serious in time of war, when officials from a distance are in communication with each other, and the

military and railroad traffic conductors have to make their desires known through and to a series of administrations varying in dialect and in terms.

The speciality of railroad language is principally connected with the nomenclature of concrete objects which can be exhibited, and their names acquired, or definitions given relating to functions and regulations. What a "lever" is, for example, can be easily demonstrated; but what a superintendent ("director") is can only be defined by reference to the business organisation of some given railway company.

But the idea of railroad language must not be confined to this, but rather extended to the organisation of the executive department, the instructions emanating from which represent phonetically the entire conception of its functions.

We need not waste time saying how highly important would be the introduction of uniformity of language in time of war among the various railroads of a united kingdom,\* the direction of whose army is entrusted to the hands of one person; but, indeed, the advantage for peace service is scarcely less. Only when uniformity has been established shall we fully know its advantages, for then the former condition of confusion of tongues will appear as incomprehensible as the idea of uniformity is now regarded. The introduction of uniformity in coinage and in weights and measures furnishes an example of this which we may apply here.

Uniformity in the nomenclature of objects appears easier of introduction than really is the case, for it is scarcely possible to show every object to every *employé* and servant on every line, and description is not always sufficient.

The most practical means of accomplishing its introduction is to consider certain large stations upon lines which have extensive traffic of various kinds, and large workshops, in which the administration and technical direction are in the hands of educated people, as so many educational stations, where the *employés* may be trained with reference to the nomenclature and the designation of objects when finally decided. In this manner a basis will be obtained in a relatively short time for the principal objects of nomenclature relative to which any gross

\* Land complex (Länder Complex) refers to the many varieties and shades of nationalities united under the German and Austrian empires.

misunderstanding could arise, and acquaintance with its advantages will soon lead to its extension.

The printing of good, and, if possible, illustrated glossaries and indexes of doubtful designations, such as "Hüttelwagen," "Kastenwagen," "Bremswagen," "Signalwagen," "Schutzwagen," &c., will hasten the generalisation of terms, and fix accurately each appellation by reference to the number and page of the index.

The introduction of uniformity of language with reference to the ideas conveyed by the designation of functions directly dependent on organisation and instruction is, however, far more difficult.

The great difficulty commences with the superintendence of affairs. For example, the functions, position, and authority attached to the word "director" are totally different in different administrations. Sometimes it designates the chief officers of the company, sometimes the heads of the various business departments, but sometimes also the superior officers, &c., of the managing authorities. The words "General Inspector," "Head Inspector," "Business Inspector," are completely unknown on some railroads, whilst on others they designate administrative authorities, and on others again mere technical branch officials.

It is the same with the designations "Ingenieur," "Betriebs-Ingenieur," "Maschinen-Ingenieur," "Baumeister," "Bahnmeister," "Oberbahnwärter," "Oberkondukteur," "Kondukteur," "Oberschaffner," "Schaffner," "Schirrmeister," "Heizhausvorstand," "Oberlokomotivführer," and many others; so that the conductor of operations extending over several lines is soon convinced that a misconception will arise from his mistaking the designations of the functionaries whom he selects for particular duties, and that his orders are pretty sure to go to the wrong man.

But the functionary designation, the nomenclature of the functions, is, as before remarked, the same in significance with the instruction which determines the duties to be performed.

Uniformity of language, with reference to the nomenclature of functions and functionaries, therefore, amounts to the same as similarity of instruction and regulation in all essential points which concern the carrying on of the business by the working

staff (Betriebs-Exekutivpersonal), for the war service of railroads is exclusively confined to that department.

*b. UNIFORMITY OF EXPRESSION BY SIGNS.*

Railroad language in signs embraces three different classes as regards purpose and form.

1. Telegraphed signs (that is, communicated by means of the electric telegraph), phonetic signs for ideas (that is, abbreviations of words), concerted ciphers to express particular ideas.

2. Particular signals; that is, signs by which the direct service is carried on. They are divided into acoustic and optical signals.

3. Outward signs for making a function or functionary known, such as uniform, badges, &c.

Of all the departments of the railway system into which it is desirable to introduce uniformity, that of telegraphed signs is the easiest, but not the least useful. Every one acquainted with the practical railroad service knows how advantageous it is to have the information which is forwarded from station to station, as regards the usual working, briefly communicated. This brevity is still more desirable in war than in peace, and increase of abbreviated conventional signs for the expression of familiar information is a means which cannot be too much cultivated for the purpose of rendering railroad telegraphing more precise and ready.

In order to prevent the loss of a great percentage of the advantages of these abbreviations, contractions, and phonetic communications, it must be practicable to use them on several lines, and from one foreign station to another. Therefore they must be upon one uniform system.

The arrangement of one system of signal writing for this purpose by a Commission of Railroad Administrations would be sufficient for the introduction of this uniformity, for it is scarcely to be supposed that any would withdraw from following it when no private reasons exist which could call in question the manifest utility of uniformity once established.

Signalling is undoubtedly the most important department in which uniformity is desirable. The signal system of German railroads is a chaos. The author has, in his larger work on "The Telegraph and Signal System of Railroads" (Voigt, Weimar, 1867), to which he here refers, completely explained its

relations, and since then no essential alteration has taken place.

A glance at the statements of that book shows the injurious as well as unnecessary confusion and want of uniformity prevailing in the department of this principal element in securing the safety and punctuality of the German railways, the extent of which would be almost inconceivable if the divisions of the country did not explain all that otherwise would be incredible in this respect.\*

In comparing the signal system of neighbouring lines, even of lines running to the same stations, it appears indeed as if no attention whatever had been paid, when fitting out a new line with signals, to existing institutions of the same kind ; no account taken of the disadvantage and danger arising from the prevalence of two, three, or more systems of signalling upon the same branch line, so that the same ideas are frequently expressed by directly opposite signs ; and not this alone, it seems as if new forms and signs were sought for with the greatest diligence, from apparently no other motive than the desire to create something novel and different.

At the same great junction stations (whose hundred different signals the engine-driver entering at night watches in bewildering confusion, like stars which from the motion of the engine through the curves of the station, appear now retrograde, now direct, to rush into each other) we find frequently upon lines running near each other that "White Light" signifies "Stop" and "Free Passage." "Green Light" here means "Curve," there "Straight Course." Here the horizontal arm of the telegraph means "Free Passage," there "Stop;" here the surface of a disc means "Stop," there "Free Passage;" here a drawn-up wire cage means "Free Entrance," there "Don't enter the Station," &c., &c.†

The number of ideas conveyed by signals which a German railway company considers necessary to the carrying on of the service amounts to fifty-eight, three times as many as are used

\* This was written before the results of the war of 1866 and that of 1870 had taken effect.

† Our British and Irish systems of light and flag signalling are pretty uniform and uniformly understood everywhere. On nearly every line, but three colours, red, green, and white, are employed, either for night or day signals. Yet this uniformity is not absolute, nor are we aware that there is any authoritative sanction to make it or to keep it absolute. Thus on a few lines four colours are used, blue being added for night use at least.

in France and England for the same purpose (*vide* pages 239—276 and annexed table in the work of Baron von Weber just quoted), and the number of objects made use of for signalling, such as optical telegraphs, discs, flags, arrows, cages, &c., amounts to forty-eight. Add to this the fact that some of the fifty-eight ideas are conveyed in twenty different forms, and we find that the total number of signals on German lines amounts to nearly a thousand! Our western neighbours on both sides of the channel, of whose railroad institutions we have not yet taken sufficient notice, are contented with a fourth of the ideas expressed and a tenth part of the signal forms, and that without in the least degree infringing upon the safety and punctuality of the service; for *uniformity and simplicity are of such importance in signalling, that the expression of several possible ideas required but occasionally should be sacrificed to them.*

In the March of the year 1841 a code of signals for English railways was settled by a meeting of railway technists and officials at Birmingham (*vide* Sign. u. Tel.-Wesen, page 48). The same took place in France, when a Commission of Inquiry, appointed by the Imperial Government, had stringently urged the establishment of a “langue universelle de signes identiques, parlant aux yeux de tous, rapidement compris et appris, même par des personnes étrangères aux chemins de fer,” &c. (*vide* p. 79 Tel. u. Sign.-Wesen).

Since then it has not occurred to any technist or official in those countries to wish to change the meaning of the principal signs by inventing new signals, although it might for an exceptional case possibly appear desirable that “Red Light,” for example, which always means “Danger,” “Stop,” should signify “Free Passage,” in order that thus the required signal for going safely on might more certainly be distinguished among the surrounding white lights. The language of railway signals has, in fact, become almost universal in England and France, so that the public in general, the engine-drivers, and the organs of the public authorities are guided by it. Indeed, it is supposed to be so universal that the signals which regulate the colossal street traffic in London are constructed upon the same principles.\*

\* The author no doubt here refers to the absurd green post and red arms not long since set up to obstruct the thoroughfare at Bridge Street, Westminster—nowhere else—and probably only not removed thence for very shame on the part of those who ever sanctioned its erection. Railway signalling is utterly inapplicable to street traffic, the conditions of which have no fixed limits, and vary every moment.

If uniformity of signal language, which necessarily need only extend to the principal signs (whilst the formation of local necessary signals may be arranged as required, provided it does not render the forms of the principal signals liable to be mistaken); if, I repeat, this uniformity be so advantageous for the peace service of railways, its advantages in time of war, when the whole railway staff, &c., of any one line may be distributed over several strange lines, must be incalculable.

As the rapidity of service, the safety and efficiency of railroads, depend upon their mutual co-operation and signalling, and the ability to comprehend it is one of the principal elements in securing these, the efficiency of railroads must naturally be increased by the introduction of uniformity in the system of signalling. We, therefore, earnestly recommend the *most energetic efforts for the introduction of uniformity in the signal system of the railroads of a united kingdom whose army forms one whole, as a principal means of increasing the efficiency of railroads for war service, and therefore of the army itself, as well as being advantageous in time of peace.*

The selection of signals to be used for this purpose has been stated in the proposals which the general assembly of German technists gave as their collective opinion, in the latest edition of the before-mentioned "Technischen Vereinbarungen über den Bau und die Betriebseinrichtungen der Eisenbahnen," pages 26 and 27, under the title "Signal Ordnung;" and this selection has greatly lightened the task of the author in his work "Telegraphen und Signal-Wesen der Eisenbahnen."

The signals mentioned in the first-named work are, in fact, the very ones for which uniformity is desirable in the interests of war, and most useful for peace service.

On the basis of this sketch of signalled ideas, and the means of conveying them, the author has compiled, with reference to the results of his researches, the detailed "Plan for Universal Signalling on German Railways,"\* which he gives at page 209 of his already-quoted work, and which is suitable for immediate employment in practice.

The introduction of uniformity in signalling is attended with difficulty, but is not impracticable. It must not be done partially, but being *very well prepared beforehand*, must without any

\* "Entwurf zu einer Allgemeinen Signal Ordnung für die Deutschen Eisenbahnen."

transition period *be commenced and put into operation at once*. All the arrangements must be completed, the officials examined as to their knowledge of the subject, and every preparation made to start on a fixed day with the new system in its entirety. The old system must be set aside in one day, and the new substituted at a particular hour, and for some one pre-appointed train. For some days the business must be carried on with especial caution, with continual and direct superintendence of the head officials, and thus the change will be made rapidly and effectually. The author has had experience in the matter, as he first carried into effect the signal system which he had projected and taught upon the State Railroad of Saxony, and which unfortunately has since received unsuitable modifications.

*Uniform, the badge of service, is, after all, nothing else than a signal, which a functionary wears, and which designates his function, as other signals express matters of fact and arrangements with respect to them.*

Uniformity in dress and service insignia is thus the complement of uniformity of functions and signals.\*

It is no despicable means of obtaining information, for it enables the seeker everywhere to find the person sought for, it guides every order to the right officer, and assists in maintaining discipline and authority, securing expedition and safety to the service, which, as I have before stated, are means of increasing its efficiency.

The system of uniforms at present in use on German railways is as complicated as the signal system itself.

The most various symbols and emblems are found to characterise a railway-station inspector or a station master, so that very often one functionary cannot discover his coequal on a neighbouring railway by his dress.

\* Possibly the importance that the author attaches to uniforms as the mark of railway position may be less amongst us. We cannot, however, avoid thinking that there is some room for improvement on our lines in this respect, both in the peace and war aspects of their working. On all our lines the higher officials, "General Manager," even "Station Masters," and so forth, wear no uniform, and it is impossible to recognise them in relation to their functions, except by a round-about set of inquiries. Probably some of these gentlemen might object to uniform, but if so, unreasonably, and in any case they should be called upon to wear an embroidered or other badge in hat or cap, by which their position should be known, and so of all other railway servants. Descending to the other end, who can distinguish on most of our lines a "porter" from a "lamp man?" yet if, say at midnight, a passenger ask the latter to remove his baggage, he probably gets no answer, and remains in doubt whether he should apply to some one else.

The system of uniform, carried to excess as it is on German railways, is a burden even in time of peace. It has been developed to excess under the influence of aesthetical companies and the German military spirit, and is not merely expensive to the companies to *purchase*, but for their servants to *wear*, for the subordinate officers decline to put their hands to work which would *soil* or *injure* their clothes, or which they consider derogatory to the rank which their uniform gives them.

This circumstance necessitates the employment of a far larger number of workpeople, who do not wear any uniform, than many a company imagines. It were far more reasonable to restrict the wearing of uniform to those railway officials who come into communication with the public in the way of their business. The rest require only to wear a badge to make known their employment, and perhaps their rank.

But it would be to the great advantage of the public in general in time of peace, and to the military man in time of war, if the superintendent (Oberschaffner) encountered in Cologne were dressed the same as the superintendent at Königsburg, and if there were no danger of the station inspector (Bahnhofs inspector) in Hamburg being mistaken by one from Frankfort for a superintendent of the line. In fact, difference of uniform might, under some circumstances, play in a small way the same part which the uniform of the early Confederate contingent (Buntheit der früheren Bundeskontingente) often played in reference to military operations, leading to disaster to one's friends.

The satisfaction with which the public everywhere greets the red cap now so extensively worn by the station authorities (Stations Vorstände), and which unmistakably guides the aggrieved party to the right place to make known his complaints, is a testimony to the advantage of uniformity in dress.

For badges for railway uniform, we recommend the Austrian as simple, cheap, free from the hindrances of epaulets and shoulder-knots, easily put on, and only requiring a glance at the collar to obtain the necessary information.

A marked distinction between the three principal classes of officials, viz., servants of the office, or account system, technical service, and the business executive, or traffic, by the colour of the uniform, recommends itself,

There is less difficulty in establishing uniformity as regards dress than in any other department. The change is attended with no danger, and even the command for the gradual exchange of worn-out garments for those under the new system would be welcome to both employers and employed, and very quickly executed, if care were taken that the new uniform be at the same time in good taste and cheap.

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### SECTION III.

#### ORGANISATION OF RAILWAY WORKSHOPS FOR THE CONSTRUCTION AND REPAIR OF WAR MATERIEL.\*

BESIDES the organisation of their business arrangements for service in time of war, railroad institutions can, in another respect, render essential service to military operations, viz., by means of their workshops for the construction and repair of locomotives.

The attention of the authorities has not been sufficiently directed to this subject.

\* The views of the author as to the possible diversions of railway shops from their natural avocations and uses, to those of armories and arsenals, so far as they are well based at all, are much more applicable to a country as widespread as Germany than to our own. Over such an area, reticulated with natural lines of defence, nothing but great disparity in strategy or in forces could prevent the contest with an invader being a more or less prolonged one. Resistance might still be prolonged by the temporary help of improvised workshops, after the main arsenals and factories of munitions should have been taken, or cut off from the defending forces. Nor should we underrate what may be done by a determined race with such means, when we call to mind what the Confederates did in 1862-65, in creating rolling mills, ammunition works, powder mills, foundries, and arsenals. But these cases have little applicability to the circumstances of our own country when actually under the invader's tramp. Time is the indispensable element for rendering any such improvised manufactoryes of use for military supply, and were our solitary arsenal to fall into the invader's hands, or become cut off by his movements, it is certain we should have no time for creating a substitute anywhere, though in a country that is almost one great workshop. Nor are the plant or tools of most of our railway workshops, which are all of a special class, so easily adaptable to any new purposes. No doubt we possess in our almost countless engineers' shops of various sorts, and in the skilled and intelligent managers and men that people them, such a power of mechanical creation as no other nation possesses; but the very perfection of our manufacturing establishments, the lavish use of special tools, the minute subdivision of labour, the lifelong addiction of the one man to the one task, as well as a certain inertness, if not incapacity, in our race to pick up new thoughts and work upon new tasks, with the rapid readiness and organising power of the French, or the patient thoroughness and studious mastery of the German workman—all tell powerfully against the probability of our being able to make any good use of railway shops or private engineering establishments for improvised arsenals. Even shops like Elswick, already engaged with artillery, or all Birming-

The North German railways possess more than thirty large workshops for the construction of all kinds of machinery, and for waggons and other rolling stock, most completely fitted up, in close connection with the lines, and employing nearly 10,000 experienced workmen. Besides these, there are on the lines more than one hundred small or secondary workshops, many of which, however, are capable of executing considerable repairs.

This immense power for the manufacture or repair of everything by the hands of the fitter, blacksmith, founder, turner, cartwright, and joiner, is nearly equally distributed over the whole land.

The labour necessary for the construction of war *materiel*—such as gun-carriages, wheelbarrows for earthworks or hospitals, boxes, transport waggons, field forges, tents, pioneers' tools, pontoons, bridges, &c.—is precisely the same in class as that daily performed with perfection and rapidity in the railway workshops, in their production and repair of locomotives, tenders and their tanks, turn-tables, and especially of railroad rolling stock of all kinds, transport waggons, and barrows of various kinds for station use.

Very little training would be requisite for the intelligent staff in these workshops; a little occasional practice in the manufacture or repair of war *materiel*, e.g., a field-battery with everything belonging to it (excepting the guns), waggons, tools, &c., in one or other of the great factories of a railway, would go a long way to fit its means and staff to assist in case of necessity in the repair or construction of all kinds of war *materiel* (except, of course, such as requires processes peculiar to itself, such as steel guns, polished cutting weapons, &c.). The advantages of possessing such important aids to fall back upon are further increased by the circumstances that these factories are so distributed over the country that there can never be

ham together, could do little or nothing within a month or two to supply the loss of Woolwich. Nothing can better show the peril of our existent position. Weedon would seem a good position in many ways for a second and an inland arsenal. But if ever we shall have a real army on the only basis for it possible, then part of its organisation must be the mapping out of our islands into manageable military districts, each with its own head-quarters, where should be concentrated not only the carriages and supplies, &c., for its own *corps d'armée*, but also should be laid up in store a supply for at least three months of small-arm and artillery ammunition, so that having these scattered over the country to draw upon during the crisis of invasion, the loss or the destruction of our central arsenal, Woolwich, would be without immediate collapse to our army.

a great distance between the battle-field and one or other of them, and that the majority can never fall into the hands of the enemy.

The adoption of the same sorts of machine tools, of the same system of screw-threads, taps, and gauges, and the same weights and measures for all military and all railway workshops, would be of great value for facilitating such transfer of tasks in war service, and would remove many difficulties and prevent many delays.

The training of the working staff for military services can be effected without difficulty or disturbance to their particular business, if no appointed time be rigidly fixed for it, and if the head of the factory have permission to arrange the military training in those pauses or slack times which every practical railroad technician knows must periodically occur in the activity of the busiest workshop.

A moderate amount of zeal and good-will being supposed, very unusual and unfavourable circumstances must concur to render it impracticable to get through a certain number of these pre-arranged abnormal tasks of an appointed kind in suitable times, enough (though relatively not very great) to keep the staff of workmen sufficiently familiar with such services when required, and in case of war would place a great part of the efficiency of the railway workshops at the disposal of the army for the repair of war *matériel*, at a period when everything else must give way to the interests of the battle-field, and the willing sacrifice of individuals and institutions must be taken for granted.

The last European wars were too rapidly decided to render the necessity of the supply and repair of war *matériel* very urgent, but if (as, alas! is not improbable) the nations should once more be opposed to each other in battle, then the advantages of having placed our railroad system with all its working organs, without injury to its peace service, in the closest and most efficient connection with the scientific strategy of our age, will be manifested, and cannot but prove an important additional element of military power to that State which shall have now, in peaceful times, best thought out and most thoroughly carried out the problems, some of the conditions of which have been here treated of.

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